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OPEN SPACE AS AN AIR RESOURCE MANAGEMENT MEASURE VOLUME IA: APPENDIX TO SINK FACTORS

U.S. ENVIRONMENTAL PROTECTION AGENCY
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by

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Abstracts of approximately 2,000 references are compiled in support of determining what is known about the sink and emission factors for air pollutants associated with soil and vegetation. Some very limited literature is also abstracted relative to water bodies as sink and sources of air pollutants. This abstracted bibliography is in support of the three volumes which comprise the final report of this project.

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The following lists and abstracts represent material derived in support of the three Volume final report prepared as part of Contract No. 68-02-2350.

IV. PLANT SPECIES SENSITIVITY LISTS

Based on the literature surveyed, tables have been constructed which list plant species which are relatively tolerant or which are relatively sensitive to air pollutants. In some instances, scientific or common names as they appeared in the original literature were antiquated. Where that occurred, the names were appropriately changed to correspond with currently accepted botanical standards of nomenclature.

The scientific name list of plant species sensitivity was not included in Volume I. However, both scientific and common name species list are presented here for reference. The common name list appears as Section IV of Volume I.

TABLE IV-1

PLANT SPECIES SENSITIVITY LISTS

Fluorine

	Reference
TOLERANT - Trees/Deciduous	
Acer platanoides (Norway maple)	733
Acer saccharum (Sugar maple)	1164
Ailanthus altissima (Tree of heaven)	536
Alnus glutinosa (European black alder)	536,1164
Betula alba (White birch)	733
Betula pendula gracilis (Cutleaf birch)	536
Celtis sp. (Hackberry)	733
Cornus florida (Flowering dogwood)	733
Cornus mas (Cornelian cherry)	1164, 536
Eleagnus angustifolia (Russian Olive) (Oleaster)	536
Fraxinus velutina (Modesto ash)	1164, 536
Larix decidua (European larch)	1687
Malus sp. (Apple)	733
Morus alba (White mulberry)	733
Platanus occidentalis (American sycamore)	733
Prunus cerasifera (Flowering plum)	1164, 536
Prunus serrulata (Oriental cherry)	536
Pyrus communis (Pear)	1164
Salix sp. (Willow)	536, 1164
Sambucus nigra (European elder)	536
Sambucus racemosa (European red elder)	536
Sorbus aucuparia (European mountain ash)	1164, 536
Sorbus domestica (American mountain ash)	536
Tilia americana (American linden) (Basswood)	1164, 536
Tilia cordata (Little leaf linden)	536
Ulmus americana (American elm)	1164, 536
TOLERANT - Trees/Coniferous	
Ilex opaca (American holly)	733
Juniperus sp. (Juniper)	1164, 536
Juniperus virginiana (Eastern red cedar)	525
Magnolia sp. (Magnolia)	733
Picea glauca (White spruce)	1164,536
Pinus nigra (Austrian pine)	1164
Tsuga canadensis (Hemlock) (Canadian hemlock)	733
Tsuga heterophylla (Western hemlock)	1687
TOLERANT - Shrubs	
Pyracantha sp. (Firethorn)	1164
Ribes sp. (Currant)	1164
Spirea prunifolia (Bridal wreath spirea)	1164
TOLERANT - Herbaceous	
Festuca sp. (Red fescue)	890N
Festuca elator (Fescue)	890N
Geranium sp. (Geranium)	16
Hibiscus gossypium (Cotton)	136, 16, 269

Fluorine (Con't)

TOLERANT - Herbaceous

	Reference
Medicago sativa (Alfalfa)	16
Melilotus sp. (Sweet clover)	16
Nicotiana sp. (Tobacco)	16
Passiflora sp. (Apricot - vine)	886C
Poa pratensis (Kentucky bluegrass)	890N
Sicyos sp. (Cucumber)	16
Solanum melongena (Eggplant)	16
Spermolepsis sp. (Celery)	16
Vitis sp. (Grapevine)	886C

INTERMEDIATE - Trees/Deciduous

Acer campestre (Hedge maple)	536, 1164
Acer saccharinum (Silver maple)	1164, 536
Amelanchier canadensis (Serviceberry)	1164
Betula pendula gracilis (Cutleaf birch)	16
Betula pendula (European white birch)	536
Carpinus betulus (European hornbeam)	536
Castenea sativa (Spanish chestnut)	536
Corylus avellana (European filbert)	536
Fagus sylvatica (European beech)	536
Fraxinus excelsior (European ash)	1164, 536
Fraxinus pennsylvanica var. lanceolata (Green ash)	536, 1164
Juglans nigra (Black walnut)	536
Juglans regia (English walnut) (Persian walnut)	1164, 536
Larix leptolepsis (Japanese larch)	1074
Malus sp. (Apple)	16
Morus rubra (Red mulberry)	536
Platanus orientalis (Oriental plane tree)	536
Populus canadensis var. jugenei (Eugene poplar)	1164, 536
Populus nigra var. italica (Lombardy poplar)	1164, 536
Populus tremuloides (Quaking aspen)	1164, 536
Prunus serrulata (Oriental cherry)	1164
Quercus robor (English oak)	536
Rhus glabra (Smooth sumac)	536
Robinia pseudoacacia (Black locust)	1164, 536
Tilia cordata (Little leaf linden)	1164, 536

INTERMEDIATE - Trees/Coniferous

Abies concolor (White fir)	1074
Abies procera (Noble fir)	1074
Ilex aquifolium (English holly)	1164, 536
Juniperus scopulorum (Western red cedar)	1074
Picea sp. (Spruce)	1074
Pinus contorta (Lodgepole pine)	1074
Pinus monticola (Western white pine)	1074
Pinus nigra (Austrian pine)	525
Pinus ponderosa (Ponderosa pine)	1074
Pseudotsuga menziesii (Douglas fir)	1074

Fluorine (Con't)

	Reference
INTERMEDIATE - Trees/Evergreen	
Thuja sp. (Arborvitae)	536, 1164
Tsuga heterophylla (Western hemlock)	1074
INTERMEDIATE - Shrubs	
Rhododendron sp. (Rhododendron)	1164
Rosa sp. (Rose)	1074, 1164, 16
Syringa vulgaris (Common lilac)	1164
Taxus cuspidata (Japanese yew)	1164, 536
INTERMEDIATE - Herbaceous	
Fagopyrum (Buckwheat)	16
Iris sp. (Iris)	16
SENSITIVE - Trees/Deciduous	
Acer negundo (Box elder)	536, 1164
Acer sp. (Maple)	765
Carpinus betulus (Hop hornbeam)	765
Larix occidentalis (Western larch)	536
Paulownia tomentosa (Paulownia)(Empress tree)	536
Prunus sp. (Plum)	16
Prunus sp. (Italian prunes)	269
Prunus armeniaca (Flowering apricot) (Apricot)	536, 16, 460
Prunus domestica 'Bradshaw' (Bradshaw plum)	536, 1164
Prunus mume (Japanese apricot)	363
SENSITIVE - Trees/Evergreen	
Abies amabilis (Cascades fir)	1074
Abies concolor (White fir)	1687
Abies nordmanniana (Nordman's fir)	1074, 1687
Abies pectinata (Silver fir)	1687
Abies procera (Noble fir)	1687
Picea abies (Norway spruce)	1074, 1687
Picea engelmannii (Engelmann spruce)	1687
Picea omorika (Serbian spruce)	1074, 1687
Picea pungens (Colorado spruce)	536, 1164
Pinus contorta (Lodgepole pine)	536, 525
Pinus ponderosa (Ponderosa pine)	536
Pinus strobus (Eastern white pine)	536
Pinus sylvestris (Scotch pine)	525,1164,536,1074
Pinus taeda (Loblolly pine)	1164, 536
Pseudotsuga menziesii (Douglas fir)	525,536,1074,1164, 1687
SENSITIVE - Shrubs	
Berberis vulgaris (Common barberry)	765
Hypericum maculatum (St. Johnswort)	1010, 765
Hypericum perforatum (St. Johnswort)	765
Lonicera alpigena (Dwarf alps honeysuckle)	765
Pinus mugo mughus (Dwarf mugo pine)	536
Vaccinium sp. (Blueberry)	1164

Fluorine (Con't)

INTERMEDIATE - Herbaceous	Reference
Amaranthus retroflexus (Amaranthus)	765
Arrhenatherum elatius (Oat grass)	765
Chenopodium alba (Goosefoot)	765
Chenopodium murale (Goosefoot)	765
Colchicum autumnale (Colchicus) (Fall crocus)	765
Dactylis glomerata (Orchard grass)	765
Iris sp. (Iris)	990
Poa annua (Annual blue grass)	765
Silene inflata (Catchfly)	765
Sinapsis arvenis (Mustard)	765
Stellaria media (Common chickweed)	765
Vitis sp. (Oregon grape)	363
Vitis vinifera (Grape)	765
Zea mays (Corn)	16

TABLE IV -2

PLANT SPECIES SENSITIVITY LISTS

General Pollution

TOLERANT - Trees/Deciduous	Reference
Acer negundo (Box elder)	886K, 890L, 890J, 890L, 886I
Ailanthus altissima (Tree of heaven)	1358
Alnus sp. (Alder)	39, 1400
Amelanchier sp. (Juneberry)	890Q
Betula lenta (Birch)	889A,886I,890Q,1400
Cornus florida (Flowering dogwood)	890Q
Crataegus sp. (Hawthorn)	889B
Crataegus mollis (Redhaw hawthorn)	890Q
Elaeagnus angustifolia (Oleaster) (Russian olive)	886K,890J,890,889A
Elaeagnus commutata (Silverberry)	890L
Fagus grandifolia (American beech) (Red beech)	39
Fraxinus sp. (Ash)	890Q, 39
Fraxinus pennsylvanica (Red ash)	890
Gingko biloba (Maidenhair tree) (Gingko)	1358
Gleditsia triacanthos (Honey locust)	1976
Larix sp. (Larch)	1400
Larix leptolepsis (Japanese larch)	787
Malus sp. (apple)	1501, 407
Malus floribunda (Ornamental apple)	890Q
Platanus acerifolia (London plane tree)	1976
Populus balsamifera (Balsam poplar)	890J, 886K, 889A
Populus canadensis (Canadian poplar) (Carolina poplar)	890L
Populus deltoides (Eastern poplar)	886N
Populus sp. (Poplar)	889A, 890Q
Prunus sp. (Cherry)	890Q, 1501, 407
Prunus amygdalus (Almond tree)	407
Prunus sp. (Plum)	407
Prunus persica (Peach)	407
Pyrus communis (Pear)	809Q
Quercus sp. (Oak)	889A
Salix caprea (Goat willow)	890L
Sambucus sp. (Elder)	890Q
Sambucus pubens (Scarlet elder)	889B, 890L
Sophora japonica (Japanese pagoda tree)	1976
Sorbus aucuparia (European mountain ash)	890Q
Ulmus sp. (Elm)	886K,889A,890J,890Q

TOLERANT - Trees/Coniferous	
Juniperus virginiana (Eastern red cedar) (Cedar)	890Q
Picea pungens (Colorado spruce)	886N, 787
Picea sitchensis (Sitka spruce)	787
Pinus nigra (Austrian pine)	41, 787
Pinus strobus (Eastern white pine)	889A
Thuja sp. (Arborvitae)	886N
Thuja plicata (Western red cedar)	787, 890Q

General Pollution (Con't)

TOLERANT - Shrubs

	Reference
Berberis mentorensis (Mentor barberry)	1501, 886I, 890Q
Euonymus sp. (Spindletree)	890L
Lonicera tatarica (Tatarian honeysuckle)	890L
Rhamnus frangula (Alder buckthorn)	886I
Ribes sp. (Alpine currant)	890Q
Rosa sp. (Hedgerow rose)	890Q
Rosa eglanteria (Sweetbriar)	890Q
Symphoricarpos albus (Snowberry)	890L
Syringa sp. (Lilac)	890L, 890Q
Syringa vulgaris (Common lilac)	886K
Vaccinium sp. (Blueberry)	407
Viburnum sp. (Viburnum)	890Q

TOLERANT - Herbaceous

Allium japonica (Onion)	38
Artemisia vulgaris (Wormwood)	38
Athyrium nipponicum (Roth)	38
Brassica napolerassica (Cabbage)	407
Cerastium triviale (Chickweed)	38
Coreopsis tinctoria (Tickseed)	38
Crepis japonica (Hawksbeard)	38
Chrysanthemum sp. (Chrysanthemum)	407
Euphorbia helioscopia (Spurge)	38
Euphorbia sieboldiana (Spurge)	38
Fragaria sp. (Strawberry)	407
Gaillardia sp. (Blanketflower)	1513
Geum sp. (Benoite)	407
Hemerocallis fulva (Day lily)	38
Hordeum vulgare (Barley	407
Hypericum sp. (St. Johnswort)	407
Lonicera periclymenum (Woodbine)	890Q
Petunia sp. (Pink satin petunia)	797
Phaseolus sp. (Bean)	407
Poa annua (Annual bluegrass)	38
Raphanus sp. (Radish)	407
Rheum rhaponicum (Rhubarb)	407
Solanum jamesii (Potatoes)	407
Stellaria media (Starwort)	38
Taraxacum platicardum (Dandelion)	38
Triticum aestivam (Wheat)	407
Vigna sp. (Peas)	407
Zea mays (Corn)	407

INTERMEDIATE - Trees/Deciduous

Acer sp. (Maple)	889A

General Pollution (Con't)

INTERMEDIATE - Trees/Deciduous

	Reference
Acer negundo (Box elder)	339A
Acer platanoides (Norway maple)	501
Acer saccharinum (Silver maple)	501
Alnus sp. (Alder)	886C, 889A
Betula sp. (Pubescent birch)	886N
Betula papyrifera (Canoe birch) (White birch)	886L, 890E
Carpinus sp. (Hornbeam)	886C
Citrus sp. (Grapefruit)	407
Crataegus sp. (Hawthorn)	886C, 733
Ficus carica (Fig)	733
Fraxinus bungeana (Ash)	38
Fraxinus longicuspis (Ash)	38
Fraxinus pennsylvanica (Red ash)	886N, 501, 890L
Fraxinus pennsylvanica var. lanceolata (Green ash)	890E
Juglans sp. (Walnut)	407
Larix decidua (European larch)	787, 886
Liriodendron tulipifera (Tulip poplar) (Yellow poplar)	501
Malus sp. (Apple)	1332
Morus sp. (Mulberry)	886C
Populus sp. (Hybrid poplar) (Aspen)	886L, 890E, 886C
Populus balsamifera (Balsam poplar)	890E, 886L
Populus nigra var. italica (Lombardy poplar)	733
Populus nigra (Black poplar)	890E
Prunus armeniaca (Apricot)	407
Prunus virginiana (Chokecherry)	733
Quercus acuta (Sawtooth oak)	38
Quercus dentata (Chestnut oak)	38
Quercus glandulifera (Glandbearing oak)	38, 886C
Quercus robor (English oak)	886N
Salix sp. (Willow)	886C
Sambucus sp. (Elder)	886C
Sorbus americana (Mountain ash)	890E
Tilia americana (American linden) (Basswood)	886, 733
Tilia cordata (Little leaf linden)	886N
Ulmus sp. (Elm)	889A

INTERMEDIATE - Coniferous

Abies sp. (Fir)	787
Chamaecyparis sp. (False cypress)	889A
Picea engelmanni (Engelmann's spruce)	889A
Picea pungens (Colorado spruce)	733
Picea omorika (Serbian spruce)	889A
Pinus contorta (Lodgepole pine)	889A
Pinus densiflora (Japanese red pine)	38
Pinus resinosa (Red pine) (Norway pine)	886N
Pinus rigida (Pitch pine)	733
Pinus strobus (E. white pine)	886N, 787
Thuja sp. (Arborvitae)	889A
Tsuga canadensis (Canadian hemlock)	787

General Pollution (Con't)

INTERMEDIATE - Shrubs

	Reference
Berberis thunbergii (Japanese barberry)	890L
Corylus sp. (Filbert)	890L
Forsythia intermedia (Forsythia)	733, 501
Juniperus sp. (Juniper)	889A
Lonicera tatarica (Tatarian honeysuckle)	501, 890J
Rosa sp. (Hedgerow rose)	890E
Spirea sp. (Spirea)	733
Syringa vulgaris (Common lilac)	890J
Weigela florida (Weigela)	501

INTERMEDIATE - Herbaceous

Adiantum pedatum (Maidenhair)	38
Allium sp. (Onion)	407
Brassica rapa (Rape seed) (Turnip)	407
Cichorium endivia (Endive)	407
Chrysanthemum sp. (Chrysanthemum)	407
Danthonia sp. (Oat)	407
Dianthus (Carnation)	407
Erigeron strigosus (Daisy fleabane)	38
Eupatorium coelestinum (Ageratum)	407
Gnaphalium multiceps (Cudweed)	38
Heliopsis elegans (Zinnias)	407
Lactuca sp. (Heat lettuce)	407
Medicago sativa (Lucerne)	407
Nasturtium indicum (Yellow cress) (Nasturtium)	38
Petasites japonica (Sweet coltsfoot)	38
Petunia sp. (Petunia)	407
Phaseolus sp. (Bean)	407
Plantago major (Common plantago)	38
Poa matsumural (Bluegrass)	38
Polygonum virginianum (Knotweed)	38
Rumex acetosa (Sorrel)	38
Senecio nikoensis (Groundsel)	38
Spermolepsis sp. (Celery)	407
Viola sp. (Violet)	38
Vitis vinifera (Grape)	733

SENSITIVE - Trees/Deciduous

Acer negundo (Box elder)	890E
Acer palmatum (Japanese maple)	38, 425
Aesculus turbinata (Buckeye)	38
Ailanthus altissima (Tree of heaven)	1501
Alnus multinervis (Alder)	38
Betula sp. (Birch)	886I, 311, 425
Catalpa speciosa (Catalpa)	311, 425
Cercis siliquastrum (Judas tree)	1501
Citrus sp. (Orange)	727
Fagus sp. (Beech)	889A
Fraxinus sp. (Ash)	733, 425, 889A

General Pollution (Con't)

SENSITIVE - Trees/Deciduous

	Reference
Larix sp. (Larch)	890K, 311, 38, 890E
Malus baccata (Siberian crabapple) (Apple)	886L, 311
Melia japonica (Mahogany)	38
Morus microphylla (Mulberry)	311
Populus alba (White poplar)	38
Populus nigra var. italica (Lombardy poplar)	311, 425
Prunus persica (Peach)	1332, 733
Prunus serotina (Wild black cherry)	1332
Prunus virginiana (Chokecherry)	733
Pyrus communis (Pear)	311
Quercus sp. (Oak)	425
Quercus alba (White oak)	733
Quercus prinus (Chestnut oak)	733
Quercus velutina (Black oak)	733
Tilia sp. (Linden)	889A
Ulmus sp. (Elm)	811, 425, 1501
Ulmus turkestanica (Pumila arborea) (Turkestan elm)	890E

SENSITIVE - Trees/Coniferous

Abies sp. (Fir)	890E,886N,886C,889A
Picea sp. (Spruce)	425,889A,886N,39,890E
Picea abies (Norway spruce)	733
Picea pungens (Colorado spruce)	733
Pinus nigra (Austrian pine)	733
Pinus ponderosa (Ponderosa pine)	311
Pinus strobus (Eastern white pine)	733, 311
Pinus sylvestris (Scotch pine)	733,886K,890J,787,889A
Pseudotsuga menziesii (Douglas fir)	425, 733

SENSITIVE - Shrubs

Mahonia aquifolium (Oregon holly grape)	733
Syringa vulgaris (Common lilac)	733
Taxus sp. (Yew)	889A

SENSITIVE - Herbaceous

Aconitum japonicum (Aconite)	38
Agrimonia pilosa (Agrimony)	38
Amaranthus palmeri (Careless weed)	311
Ambrosia artemisifolia (Ragweed)	311
Arachis sp. (Peanut)	727
Aster bigelobii (Aster)	311
Avena sativa (Oat)	311
Beta vulgaris (Beet)	311, 407
Beta vulgaris var. cicla (Swiss chard)	311, 407

General Pollution (Con't)

SENSITIVE - Herbaceous

	Reference
Brassica oleraccea var. batrytis (Broccoli)	311
Brassica rapa (Turnip)(Rape seed)	311
Boleracea var. gemmifera (Brussel sprouts)	311
Capsicum prutescens (Pepper bell, chili)	311
Centaurea cyanus (Bachelors button)	311
Chenopodium album (Goosefoot)	407
Cichorium endivia (Endive)	311
Cirsium inconiptum (Thistle)	38
Commelina sp. (Mosses)	1490
Convolvulus arvensis (Bindweed)	311
Cosmos bipinnatus (Cosmos)	311
Cucurbita maxima (Squash)	311
Cucurbita pepo (Pumpkin)	311
Daucus carota (Carrot)	311
Equisetum arvense (Horsetail)	311
Erigeron canadensis (Fleabane)	38
Fagopyrum sagittatum (Buckwheat)	311, 1332
Galinsoga parvifolia (Galinsoga)	407
Galium strigosum (Bedstraw)	38
Gaura parvifolia (Velvet-weed)	311
Gaylussacia sp. (Huckleberry)	733
Gossypium sp. (Cotton)	311
Glycine max. (Soybean)	311, 727
Helianthus (Sunflower)	311
Hibiscus esculentus (Okra)	311
Hordeum vulgare (Barley)	311
Lactuca sativa (Lettuce)	311
Lactuca scariola (Lettuce, prickly)	311
Laportea bulbifera (Wood nettle)	38
Lycopersicium esculentum (Tomato)	1332, 727
Malva parvifolia (Mallow	311
Medicago sativa (Alfalfa)	727, 311
Melilotus sp. (Clover)	311
Mirabilis jalapa (Four o'clock)	311
Petunia sp. (Gypsy petunia)	797
Phaseolus sp.(Green beans)	727
Phaseolus vulgaris (Bean)	311
Plantago major (Plantain)	311
Poa sp. (Bluegrass)	886C
Polygonatum latifolium (Solomon's seal)	38
Potentilla chinensis (Cinquefoil)	38
Phaseolus limensis (Lima bean)	727
Raphanus sativus (Radish)	311, 407
Rheum Rhaponicum (Rubarb)	311
Rumex sp.(Sorrel)	407
Sumex crispus (Curly clock)	311
Secale cereale (Rye)	311
Smilax racemosa (Catbriar)	733
Solanum jamesii (Wild potato)	727
Spinacia oleracea (Spinach)	727, 311, 407

General Pollution (Con't)

SENSITIVE - Herbaceous

	Reference
Ipomoea batatas (Sweet potato)	311
Ipomoea purpurea (Morning glory)	311
Stellaria media (Chickweed)	407
Trifolium sp. (Clover)	311
Triticum sp. (Wheat)	311
Verbena canadensis (Vervain)	311
Viola sp. (Violet)	311
Vigna sinensis (Pea)	890K
Zea mays (Corn)	1332
Zinnia elegans (Zinnia)	311

SENSITIVE - Fungi

Microsphaera guezina	886C
Oidium guezina	886C

TABLE IV -3

PLANT SPECIES SENSITIVITY LISTS

Hydrogen Chloride

	Reference
TOLERANT - Trees/Deciduous	
Acer sp. (Maple)	536
Betula sp. (Birch)	536
Eleagnus angustifolia (Russian olive) (Oleaster)	536
Juglans regia (Persian Walnut) (English walnut)	886C
Prunus sp. (Cherry)	886C
Prunus serotina (Black cherry)	536
Pyrus communis (Pear)	536
Quercus sp. (Oak)	536
Quercus borealis (Red oak)	536
TOLERANT - Trees/ Coniferous	
Abies balsamea (Balsam fir)	536
Picea abies (Norway spruce)	536
Pinus banksiana (Jack pine)	536
Pinus echinata (Short leaf pine)	536
Pinus nigra (Austrian pine)	536, 1104
Pinus strobus (Eastern white pine)	536
Pinus taeda (Loblolly pine)	536
Thuja sp. (Arborvitae)	536
Tsuga canadensis (Canadian hemlock)	536
TOLERANT - Shrub	
Taxus sp. (Yew)	536
TOLERANT - Herbaceous	
Daucus carota (Carrot)	187
Vitis sp. (Grapevine)	886C
INTERMEDIATE - Trees/Deciduous	
Nyssa sylvatica (Black gum)	536
Prunus serotina (Black cherry)	536
INTERMEDIATE - Trees/ Coniferous	
Pinus banksiana (Jack pine)	536
Pinus echinata (Short leaf pine)	536
SENSITIVE - Trees/Deciduous	
Acer negundo (Box elder)	536
Acer saccharum (Sugar maple)	536
Aesculus hippocastanum (Horsechestnut)	536
Ailanthus altissima (Tree of heaven)	536
Larix sp. (Larch)	536
Liquidambar styraciflua (Sweetgum)	536
Malus sp. (Apple)	536

Hydrogen Chloride (Con't)

SENSITIVE - Trees/Deciduous

	Reference
Prunus sp. (Cherry)	536
Quercus palustris (Pin oak)	536
Sassafras albidum (Sassafras)	536

TABLE IV-4

PLANT SPECIES SENSITIVITY LISTS

Nitrogen Dioxide

	Reference
TOLERANT - Trees/Deciduous	
Fagus sp. (Beech)	16
Gingko biloba (Maidenhair tree) (Gingko)	16
Quercus sp. (Oak)	16
TOLERANT - Trees/ Coniferous	
Pinus nigra (Austrian pine)	16
TOLERANT - Herbaceous	
Allium sp.(Onion)	16
Brassica sp. (Cabbage)	16
INTERMEDIATE - Trees/ Coniferous	
Larix decidua (European larch)	536
SENSITIVE - Trees/Deciduous	
Acer palmatum (Japanese maple)	536
Acer platanoides (Norway maple)	536
Carpinus betulus (European hornbeam)	536
Fagus sylvatica (European beech)	536
Gingko biloba (Maidenhair tree) (Gingko)	536
Malus sp. (Apple)	536
Pyrus communis (Pear)	536
Robinia pseudoacacia (Black locust)	536
Sambucus racemosa (European red elder)	536
Tilia cordata (Little leaf linden)	536
Tilia grandiflora (Large leaf linden)	536
SENSITIVE - Trees/Coniferous	
Picea glauca (White spruce)	536
Picea pungens (Colorado spruce)	536
Pinus nigra (Austrian pine)	536
Pinus strobus (Eastern white pine)	536
SENSITIVE - Shrubs	
Pinus mugo mughus (Dwarf mugo pine)	536
SENSITIVE - Herbaceous	
Daucus carota (Carrot)	16
Hordeum sp. (Barley)	16
Lactuca sp. (Lettuce)	1849, 16
Lathyrus odoratus (Sweat peas)	16
Nicotiana sp. (Tobacco)	16
Phaseolus sp. (Kidney beans)	16
Rumex sp. (Begonia)	16
Trifolium pratense (Red clover)	16

TABLE IV-5

PLANT SPECIES SENSITIVITY LISTS

Ozone

	Reference
TOLERANT - Trees/Deciduous	
Acacia sp. (Acacia)	181
Acer platanoides (Norway maple)	536, 1164
Acer rubrum (Red maple)	536, 1164
Acer saccharum (Sugar maple)	536, 1137
Alnus sp. (Alder)	1164
Betula papyrifera (White birch)	1137
Betula pendula (European white birch)	536, 1164
Cornus florida (Flowering dogwood)	536, 1164
Ficus carica (Fig)	181
Fraxinus sp. (Ash)	181
Gingko biloba (Maidenhair tree)	181
Juglans nigra (Black walnut)	1164, 536
Platanus occidentalis (American sycamore)	1074, 1164, 990
Prunus sp. (Plum)	181
Quercus imbricaria (Shingle oak)	536, 1164
Quercus robor (English oak)	536, 1164
Quercus borealis (Red oak)	1164
Salix babylonica (Weeping willow)	1164
Sequoia gigantea (Giant sequoia)	536
Sequoia sempervirens (Redwood)	536
Sorbus aucuparia (European mountain ash)	536
Tilia sp. (Linden) (Basswood)	1137
Tilia cordata (Little leaf linden)	1164
TOLERANT - Trees/Coniferous	
Abies balsamea (Balsam fir)	1137, 536, 1164, 774
Abies concolor (White fir)	774, 1164, 1137
Juniperus virginiana (Eastern red cedar)	181
Picea abies (Norway spruce)	1137, 774, 1164, 536
Picea glauca (White spruce)	536, 1164
Picea glauca densata (Black hills spruce)	774, 1164, 536, 1137
Picea pungens (Colorado spruce)	1137, 536, 1164, 774
Pinus banksiana (Jack pine)	1074
Pinus lambertiana (Sugar pine)	536
Pinus monophylla (Singleleaf pinyon pine)	536
Pinus resinosa (Red pine) (Norway pine)	1137, 1164, 774, 536
Pinus sabiniana (Digger pine)	536
Pinus torreyana (Torrey pine)	536
Pinus virginiana (Virginia pine)	1074
Pseudotsuga menziesii (Douglas fir)	774, 1137, 536, 1164
Thuja sp. (Arborvitae)	774, 1164, 536
TOLERANT - Shrubs	
Hedera sp. (Ivy)	181
TOLERANT - Herbaceous	
Ajuga sp. (Bugleweed) (Carpet bugle)	181
Ceratostigma plumbaginoides (Leadwort)	181
Cypripedium sp. (Lady's slipper)	181

Ozone (Con't)

	Reference
TOLERANT - Herbaceous	
Eschscholtzia californica (California poppy)	181
Petunia sp. (Petunia)	1015, 1074
TOLERANT - Fungi	
Alternaria sp.	48
Chaetomium sp.	48
Stemphylium loti	48
Stemphylium sarcinaeforme	48
INTERMEDIATE - Trees/Coniferous	
Abies concolor (White fir)	536
Libocedrus decurrens (California incense cedar)	536
Pinus coulteri (Coulter pine)	536
Pseudotsuga macrocarpa (Big cone Douglas fir)	536
SENSITIVE - Trees/Deciduous	
Acer negundo (Boxelder)	536, 1164
Acer saccharinum (Silver maple)	536, 1164
Alnus sp. (Alder)	536
Catalpa speciosa (Catalpa)	1164
Cercis siliquastrum (Judas tree)	536
Fraxinus americana (White ash)	990, 1137, 1074, 536, 1164
Fraxinus pennsylvanica var. lanceolata (Green ash)	536, 1164
Gleditsia triacanthos (Honeylocust)	1164, 536
Gleditsia triacanthosvar. inermis (Thornless honeylocust)	1074
Larix decidua (European larch)	990,1164,1137,536
Larix leptolepsis (Japanese larch)	1164, 536, 77
Liquidambar styraciflua (Sweetgum)	1164, 536
Liriodendron tulipifera (Tulip poplar) (Yellow poplar)	990, 1164, 536, 1074, 1137
Malus baccata (Siberian crab apple)	536, 1164
Morus alba (Mapleleaf mulberry) (White mulberry)	536
Platanus occidentalis (American sycamore)	1074
Platanus racemosa (California sycamore)	536
Populus sp. (Hybrid poplar)	-
Populus tremuloides (Quaking aspen)	536, 1164
Quercus alba (White oak)	1164, 536, 1137
Quercus coccinea (Scarlet oak)	1164, 536
Quercus gambellii (Gambel oak)	1164, 536
Quercus palustris (Pin oak)	536, 1164
Robinia pseudoacacia (Black locust)	1164, 536
Salix babylonica (Weeping willow)	536
Tilia cordata (Little leaf linden)	536
Ulmus americana (American elm)	1164
SENSITIVE - Trees/Coniferous	
Pinus banksiana (Jack pine)	774, 536, 1164

Ozone (Con't)

SENSITIVE - Trees/Coniferous	Reference
Pinus jeffreyi (Jeffery pine)	536
Pinus nigra (Austrian pine)	1164, 536, 774, 1137
Pinus ponderosa (Ponderosa pine)	536
Pinus radiata (Monterey pine)	536
Pinus rigida (Pitch pine)	1164,1137,774,536
Pinus strobus (Eastern white pine)	536, 774, 1137, 532, 990, 1164
Pinus sylvestris (Scotch pine)	774, 536, 990
Pinus virginiana (Virginia pine)	536, 774, 1137
Tsuga canadensis (Canadian hemlock)	536, 1137

SENSITIVE - Shrubs	
Camelia sp. (Camellia)	2
Ligustrum vulgare (Common privet)	1164
Spirea prunifolia (Bridal wreath spirea)	1164
Symphoricarpos albus (Snowberry)	536
Syringa vulgaris (Common lilac)	990, 1164

SENSITIVE - Herbaceous	
Aster sp. (Aster)	990
Nicotiana sp. (Tobacco)	599
Salvia sp. (Sage)	990

SENSITIVE - Fungi	
Colletotrichum lagenarium	48
Fusarium oxysporum	48
Verticillium albo-atrum	48
Verticllium dahliae	48

TABLE IV-6

Pan PLANT SPECIES SENSITIVITY LISTS

	Reference
TOLERANT - Trees/Deciduous	
Acer saccharum (Sugar maple)	536
Larix decidua (European larch)	536
Larix leptolepsis (Japanese larch)	536
TOLERANT - Trees/Coniferous	
Picea glauca (White spruce)	536
Picea pungens (Colorado spruce)	536
Pinus banksiana (Jack pine)	536
Pinus nigra (Austrian pine)	536
Pinus rigida (Pitch pine)	536
Pinus strobus (Eastern white pine)	536
Tsuga canadensis (Canadian hemlock)	536
SENSITIVE - Trees/Deciduous	
Liriodendron tulipifera (Yellow poplar)	536
Tilia cordata (Little leaf linden)	536
SENSITIVE - Herbaceous	
Aster sp. (Aster)	990
Chaenorrhinum sp. (Snapdragon)	990
Chrysanthemum sp. (Chrysanthemum)	990
Lactuca sp. (Lettuce)	1849
Petunia sp. (Petunia)	990
Primula sp. (Primrose)	990
Salvia sp. (Sage)	990

TABLE IV-7

PLANT SPECIES SENSITIVITY LISTS

Particulates - Smoke

	Reference
TOLERANT - Trees/Deciduous	
Larix decidua (European larch)	1604
Sambucus pubens (Scarlet elder)	1390
Ulmus americana (American elm)	547
TOLERANT - Shrub	
Vaccinium sp. (Cranberry)	187
TOLERANT - Herbaceous	
Polygonum cilinode (Knotweed)	1390
INTERMEDIATE - Trees/Deciduous	
Acer sp. (Maple)	1604
Alnus sp. (Alder)	1604
Alnus rhombifolia (White alder)	1604
Betula sp. (Birch)	1604
Carpinus caroliniana (American hornbeam)	1604
Fagus grandifolia (Red beech) (American beech)	1604
Populus sp. (Poplar)	1604
Quercus racemosa (Raceme oak)	1604
Quercus robur (formerly called penduculata;English oak)	1604
Quercus borealis (Red oak)	1604
INTERMEDIATE - Trees/Coniferous	
Pinus nigra (Austrian pine)	1604
Pinus strobus (Eastern white pine)	1604
Pinus sylvestris (Scotch pine)	1604
SENSITIVE - Trees/Deciduous	
Crataegus monogyna (Single-seeded hawthorne)	1675
Populus tremuloides (Quaking aspen)	1390
SENSITIVE - Trees/Coniferous	
Abies sp. (Fir)	1604
Picea abies (excelsa) (Norway spruce)	1604
Picea glauca (White spruce)	1390
Picea mariana (Black spruce)	1390
Pinus strobus (Eastern white pine)	1390
SENSITIVE - Herbaceous	
Poa annua (Annual bluegrass)	269

TABLE IV-8

PLANT SPECIES SENSITIVITY LISTS

Sulfur Dioxide

TOLERANT - Trees/Deciduous	Reference
Acer campestre (Hedge maple)	536, 1164
Acer rubrum (Red maple)	1164
Acer saccharum (Sugar maple)	1164
Acer spicatum (Mountain maple)	1164
Betula sp. (Birch)	64, 523, 1187
Carpinus sp. (Hornbeam)	1187
Carpinus betulus (European hornbeam)	536
Cornus florida (Flowering dogwood)	1164, 536
Fagus sp. (Beech)	1187, 886C
Fagus sylvatica (European beech)	536
Fraxinus sp. (Ash)	886C
Fraxinus americana (White ash)	138
Fraxinus excelsior (European ash)	369
Fraxinus pennsylvanica lanceolata (Green ash)	536, 1164
Gingko biloba (Maidenhair tree)(Gingko)	1164, 369
Regia juglans regia (Persian walnut)	886C
Larix sp. (Larch)	44
Liriodendron tulipifera (Tulip poplar)(Yellow poplar)	16, 1164, 369
Nyssa sylvatica (Black gum)	1169, 536
Oxydendron arboreum (Sourwood)	369
Platanus occidentalis (American sycamore)	1164
Platanus orientalis (Oriental plane tree)	1164
Populus sp. (Poplar)	369
Populus deltoides (Eastern poplar) (Cottonwood)	1164, 536
Quercus sp. (Oak)	44
Quercus borealis (Red oak)	1164, 44
Quercus palustris (Pin oak)	1164
Quercus robor (English oak)	1164, 536
Robinia pseudoacacia (Black locust)	536
Salix sp. (Willow)	369
Sambucus pubescens (Red berried elder)	1074
Sorbus aucuparia (European mountain ash)	369
Tilia sp. (Basswood) (Linden)	369
Ulmus glabra (Smooth elm)	369
TOLERANT - Trees/Coniferous	
Chamoecyparis lawsoniana (Lawson false cypress)	536
Ilex aquifolium (English holly)	1164, 536
Picea sp. (Spruce)	886C
Picea glauca (White spruce)	1164
Pinus nigra (Austrian pine)	525 1164, 536
Thuja occidentalis (Arborvitae)	1164
Thuja plicata (Western red cedar)	1164
Tsuga canadensis (Canadian hemlock)	1074
TOLERANT - Shrubs	
Juniperus sp. (Juniper)	1164, 536
Pinus mugo mughus (Dwarf mugo pine)	536

Sulfur Dioxide (Con't)

TOLERANT - Herbaceous

	Reference
Avena sp. (Oats)	886C
Bouteloua barbata (Grama grass)	1365
Dactilus glomerada (Orchard grass)	136
Festuca elatior (Meadow fescue)	136
Heliotropium sp. (Heliotrope)	886C
Hilaria jamesii (Galleta)	1365
Lathyrus odoratus (Sweetpea)	886C
Medicago sativa (Alfalfa)	886C
Polygonum cilinode (Fringed bindweed)	1074
Primula sp. (Primrose)	886C
Zea mays (Corn)	16

INTERMEDIATE - Trees/Deciduous

Acer platanoides (Norway maple)	1164
Malus sp. (Apple)	16
Populus balsamifera (Balsam poplar)	1164, 536
Populus grandidentata (Bigtooth aspen)	1164
Prunus armeniaca (Apricot)	16

INTERMEDIATE - Trees/Coniferous

Abies balsamea (Balsam fir)	536, 1164, 525
Abies concolor (White fir)	536
Abies pectinata (Silver fir)	536
Pinus contorta (Lodgepole pine)	536, 525
Pinus sylvestris (Scotch pine)	1164
Pseudotsuga menziesii (Douglas fir)	1164, 525, 536

INTERMEDIATE - Shrubs

Rosa sp. (Rose)	16

INTERMEDIATE - Herbaceous

Hibiscus sp. (Cotton)	16
Iris sp. (Iris)	16

SENSITIVE - Trees/Deciduous

Acer sp. (Maple)	1187
Acer spicatum (Mountain maple)	44
Aesculus hippocastanum (Horse chestnut)	44
Alnus sp. (Alder)	119, 732
Amelanchier sp. (Serviceberry)	1164
Amelanchier utahensis (Utah serviceberry)	1164
Betula sp. (Birch)	1164, 1119
Betula papyrifera (White birch) (Canoe birch)	732
Carpinus sp. (Hornbeam)	44
Catalpa speciosa (Catalpa)	1164
Crataegus oxyacantha (Scarlet hawthorn)	990

Sulfur Dioxide (Con't)

SENSITIVE - Trees/Deciduous

	Reference
Fraxinus americana (White ash)	773
Juglans regia (English walnut) (Persian walnut)	1164
Larix sp. (Larch)	732, 1164
Malus sp. (Apple)	1164
Morus microphylla (Texas mulberry)	1164
Platanus occidentalis (American sycamore)	1164
Populus sp. (Aspen) (Poplar)	732, 1187
Populus angustifolia (Narrowleaf cottonwood)	1365
Populus nigra var. italica (Lombardy poplar)	1164
Populus tremuloides (Quaking aspen)	1164, 119
Prunus avium (Mazzard cherry)	886C
Prunus sp. (Cherry)	732
Prunus virginiana (Chokecherry)	938
Pyrus communis (Pear)	1164
Salix sp. (Willow)	1164, 732
Sambucus coerulea (Blueberry elder)	732
Sorbus aucuparia (European mountain ash)	732, 1187
Sorbus americana (Mountain ash)	1164
Ulmus americana (American elm)	1164

SENSITIVE - Trees/ Coniferous

Abies sp. (Fir)	119
Picea engelmannii (Engelman's spruce)	1164
Picea mariana (Black spruce)	1164
Picea sitchensis (Sitka spruce)	732
Pinus banksiana (Jack pine)	1164
Pinus monticola (Western white pine)	1164
Pinus ponderosa (Ponderosa pine)	1164, 1007
Pinus resinosa (Red pine) (Norway pine)	16
Pinus strobus (Eastern white pine)	990, 1164, 1074, 563, 732, 773, 119
Pinus sylvestris (Scotch pine)	1074, 525
Pinus virginiana (Virginia pine)	773
Pseudotsuga menziesii (Douglas fir)	990
Thuja plicata (Western red cedar)	1074
Tsuga canadensis (Canadian hemlock)	1164
Tsuga mertensiana (Mountain hemlock)	1164

SENSITIVE - Shrubs

Kalmia latifolia (Mountain laurel)	1164
Physocarpus capitatus (Ninebark)	1164
Rosa woodsii (Wild rose)	1365
Symphoricarpos aerophilus (Snowberry)	1365

SENSITIVE - Herbaceous

Astragalus utahensis (Locoweed)	1365
Bromus inermis (Hungarian brome)	136
Chenopodium ofrenonti (Goosefoot)	1365

Sulfur Dioxide (Con't)

SENSITIVE - Herbaceous

	Reference
Cucurbita sp. (Squash)	938
Cynoglossum officinale (Hound's tongue)	1365
Fagopyrum Sp. (Buckwheat)	16
Geranium sp. (Geranium)	16
Gilia agregata (Scarlet Gilia)	1365
Gossypium sp.	16
Graveolens sp.	938
Helianthus sp. (Sunflower)	886C
Lactuca sp. (Lettuce)	1844
Marius sp.	16
Medicago sativa (Alfalfa)	938, 732
Medicago sativa (Lucerne)	1007
Melilotus sp (Sweet clover)	732, 16
Nicotiana sp. (Tobacco)	16
Oenothera sp. (Evening primrose)	1365
Oryzopsis hymenoides (Indian rice grass)	1365
Petunia sp. (Petunia)	1009
Rumex venosus (Begonia)	990, 1009
Sicyos angulatus (Cucumber)	16
Solanum melongena (Eggplant)	16
Solanum tuberosum (Potato)	1007
Spermolepsis sp. (Celery)	16
Sphaeralcea munroana (Globe mallow)	1365
Trifolium pratense (Red clover)	136
Triticumaestivum	1007
Verbena sp. (Vervain)	990
Viola sp. (Violet)	990
Vitis sp. (Grape)	938

TABLE IV- 9

PLANT SPECIES SENSITIVITY LISTS

Fluorine

TOLERANT - Trees/Deciduous	Reference
Apple *Malus sp.*	733
American elm *Ulmus americana*	1164, 536
American linden (Basswood) *Tilia americana*	1164, 536
American mountain ash *Sorbus domestica*	536
American sycamore *Platanus occidentalis*	733
Basswood (American linden) *Tilia americana*	1164, 536
Cornelian cherry *Cornus mas*	1164, 536
Cutleaf birch *Betula pendula var. gracilis*	536
European black alder *Alnus glutinosa*	536, 1164
European elder *Sambucus nigra*	536
European larch *Larix decidua*	1687
European mountain ash *Sorbus aucuparia*	1164, 536
European red elder *Sambucus racemosa*	536
Flowering dogwood *Cornus florida*	733
Flowering plum *Prunus cerasifera*	1164, 536
Hackberry *Celtis sp.*	733
Litte leaf linden *Tilia cordata*	536
Modesto ash *Fraxinus velutina*	1164, 536
Norway maple *Acer platanoides*	733
Oleaster (Russian Olive) *Eleagnus angustifolia*	536
Oriental cherry *Prunus serrulata*	536
Pear *Pyrus communis*	1164
Russian olive (Oleaster) *Eleagnus angustifolia*	536
Sugar maple *Acer saccharum*	1164
Tree of heaven *Ailanthus altissima*	536
Willow *Salix sp.*	536, 1164
White birch *Betula alba*	733
White mulberry *Morus alba*	733
TOLERANT - Trees/ Coniferous	
American holly *Ilex opaca*	733
Austrian pine *Pinus nigra*	1164
Canadian hemlock (Hemlock) *Tsuga canadensis*	733
Eastern red cedar *Juniperus virginiana*	525
Hemlock (Canadian hemlock) *Tsuga canadensis*	733
Juniper *Juniperus sp.*	1164, 536
Magnolia *Magnolia sp.*	733
Western hemlock *Tsuga heterophylla*	1687
White spruce *Picea glauca*	1164, 536
TOLERANT - Shrubs	
Bridal wreath spirea *Spirea prunifolia*	1164
Currant *Ribes sp.*	1164
Firethorn *Pyracantha sp.*	1164
TOLERANT - Herbaceous	
Alfalfa *Medicago sativa*	16

Fluorine (Con't)

TOLERANT - Herbaceous

	Reference
Apricot - vine *Passiflora sp.*	886C
Celery *Spermolepsis sp.*	16
Cotton *Gossypium sp.*	136, 16, 269
Cucumber *Sicyos sp.*	16
Eggplant *Solanum melongena*	16
Fescue *Festuca elator*	890N
Geranium *Geranium sp.*	16
Gladiolus	886C
Grapevine *Vitis sp.*	886C
Kentucky bluegrass *Poa pratensis*	890N
Red Fescue *Festuca sp.*	890N
Sweet clover *Melilotus sp.*	16
Tobacco *Nicotiana sp.*	16

INTERMEDIATE - Trees/Deciduous

Apple *Malus sp.*	16
Black locust *Robinia pseudoacacia*	1164, 536
Black walnut *Juglans nigra*	536
Cutleaf birch *Betula pendula var.gracilis*	16
English oak *Quercus robor*	536
English walnut (Persian walnut) *Juglans regia*	1164, 536
Eugene poplar *Populus canadensis var. jugenci*	1164, 536
European ash *Fraxinus excelsior*	1164, 536
European beech *Fagus sylvatica*	536
European filbert *Corylus avellana*	536
European hornbeam *Carpinus betulus*	536
European white birch *Betula pendula*	536
Green ash *Fraxinus pennsylvanica lanceolata*	536, 1164
Hedge maple *Acer campestre*	536, 1164
Japanese larch *Larix leptolepsis*	1074
Little leaf linden *Tilia cordata*	1164, 536
Lombardy poplar *Populus nigra var. italica*	1164, 536
Oriental cherry *Prunus serrulata*	1164
Oriental plane tree *Platanus orientalis*	536
Persian walnut (English walnut) *Juglans regia*	1164, 536
Quaking aspen *Populus tremuloides*	1164, 536
Red mulberry *Morus rubra*	536
Serviceberry *Amelanchier canadensis*	1164
Silver maple *Acer saccharinum*	1164, 536
Smooth sumac *Rhus glabra*	536
Spanish chestnut *Castenea sativa*	536

INTERMEDIATE - Trees/ Coniferous

Aborvitae *Thuja sp.*	536, 1164
Austrian pine *Pinus nigra*	525
Douglas fir *Pseudotsuga menziesii*	1074
English holly *Ilex aquifolium*	1164, 536
Lodgepole pine *Pinus contorta*	1074

Fluorine (Con't)

	Reference
INTERMEDIATE - Trees/ Coniferous	
Noble fir *Abies procera*	1074
Ponderosa pine *Pinus ponderosa*	1074
Spruce *Picea sp.*	1074
Western hemlock *Tsuga heterophylla*	1074
Western red cedar *Juniperus scopulorum*	1074
Western white pine *Pinus monticola*	1074
White fir *Abies concolor*	1074
INTERMEDIATE - Shrubs	
Common lilac *Syringa vulgaris*	1164
Japanese yew *Taxus cuspidata*	1164, 536
Rhododendron *Rhododendron sp.*	1164
Rose *Rosa sp.*	1074, 1164, 16
INTERMEDIATE - Herbaceous	
Buckwheat *Fagopyrum*	16
Iris *Iris sp.*	16
SENSITIVE - Trees/Deciduous	
Apricot (Flowering apricot) *Prunus armeniaca*	536, 16, 460
Box elder *Acer negundo*	536, 1164
Bradshaw plum *Prunus domestica 'Bradshaw'*	536, 1164
Empress tree *Paulownia tomentosa*	536
Flowering apricot (Apricot) *Prunus armeniaca*	536, 16, 460
Hop hornbeam *Carpinus betulus*	765
Italian prunes *Prunus sp.*	269
Japanese apricot *Prunus mume*	363
Maple *Acer sp.*	765
Moorhead apricot	363
Paulownia (Empress tree) *Paulownia tomentosa*	536
Plum *Prunus sp.*	16
Western larch *Larix occidentalis*	536
SENSITIVE - Trees/ Coniferous	
Cascades fir *Abies amabilis*	1074
Colorado spruce *Picea pungens*	536,1164
Douglas fir *Pseudotsuga menziesii*	525, 536, 1074, 1164 1687
Eastern white pine *Pinus strobus*	536
Engelmann spruce *Picea engelmannii*	1687
Loblolly pine *Pinus taeda*	1164, 536
Lodgepole pine *Pinus contorta*	536, 525
Noble fir *Abies procera*	1687
Nordman's fir *Abies nordmanniana*	1074, 1687
Norway spruce *Picea abies*	1074, 1687
Ponderosa pine *Pinus ponderosa*	536
Scotch pine *Pinus sylvestris*	525, 1164, 536, 1074

Flourine (Con't)

SENSITIVE - Trees/Evergreen

	Reference
Serbian spruce *Picea omorika*	1074, 1687
Silver fir *Abies pectinata*	1687
White fir *Abies concolor*	1687

SENSITIVE - Shrubs

Blueberry *Vaccinium sp.*	1164
Common barberry *Berberis vulgaris*	765
Dwarf alps honeysuckle *Lonicera alpigena*	765
Dwarf mugo pine *Pinus mugo mughus*	536
St. Johnswort *Hypericum maculatum*	1010, 765
St. Johnswort *Jupericum perforatum*	765

SENSITIVE - Herbaceous

Amaranthus *Amaranthus retroflexus*	765
Annual blue grass *Poa annua*	765
Catchfly *Silene inflata*	765
Colchis (Fall crocus) *Colchicum autumale*	765
Common chickweed *Stellaria media*	765
Corn *Zea mays*	16
Fall crocus (Colchis) *Colchicum autumale*	765
Gladiolus	990, 363, 318, 886C, 16, 136, 269
Goosefoot *Chenopodium alba*	765
Goosefoot *Chenopodium murale*	765
Grape *Vivis vinifera*	765
Iris *Iris sp.*	990
Mustard *Sinapsis arvenis*	765
Oat grass *Arrhenatherum elatius*	765
Orchard grass *Dactylis glomerata*	765
Oregan grape *Vitis sp.*	363
Tulip	318

PLANT SPECIES SENSITIVITY LISTS

General Pollution

TOLERANT - Trees/Deciduous

	Reference
Alder *Alnus sp.*	39, 1400
Almond tree *Prunus amygdalus*	407
American beech (Red beech) *Fagus grandifolia*	39
Apple *Malus sp.*	787
Ash *Fraxinus sp.*	890Q, 39
Balsam poplar *Populus balsamifera*	890J, 886K, 889A
Birch *Betula lenta*	889A,886I,8900,1400
Box elder *Acer negundo*	886K,890L,890J, 890L,886I
Canadian poplar (Carolina poplar) *Populus canadensis*	890L
Carolina poplar (Canadian poplar) *Populus canadensis*	890L
Cherry *Prunus sp.*	890Q, 1501, 407
Eastern poplar *Populus deltoides*	886N
Elder *Sambucus sp.*	890Q
Elm *Ulmus sp.*	886K,889A,890J,890Q
European mountain ash *Sorbus aucuparia*	890Q
Flowering dogwood *Cornus florida*	890Q
Gingko (Maidenhair tree) *Gingko biloba*	1358
Goat willow *Salix caprea*	890L
Hawthorn *Crataegus sp.*	889B
Honey locust *Gleditsia triacanthos*	1976
Japanese larch *Larix leptolepsis*	787
Japanese pagoda tree *Sophora japonica*	1976
Juneberry *Amelanchier sp.*	8900
Larch *Larix sp.*	1400
London plane tree *Platanus acerifolia*	1976
Maidenhair tree (Gingko) *Gingko biloba*	1358
Oak *Quercus sp.*	889A
Oleaster (Russian olive) *Elaeagnus angustifolia*	886K,890J,890,889A
Ornamental apple *Malus floribunda*	890Q
Peach *Prunus persica*	407
Pear *Pyrus communis*	809Q
Plum *Prunus sp.*	407
Poplar *Populus sp.*	889A, 890Q
Red ash *Fraxinus pennsylvanica*	890
Red beech (American beech) *Fagus grandifolia*	39
Redhaw hawthorn *Crataegus mollis*	890Q
Russian olive (Oleaster) *Elaeagnus angustifolia*	886K,890J,890,889A
Scarlet elder *Sambucus pubens*	889B, 890L
Silverberry *Elaeagnus commutata*	890L
Tree of heaven *Ailanthus altissima*	1358

TOLERANT - Trees/ Coniferous

Arborvitae *Thuja sp.*	886N
Austrian pine *Pinus nigra*	41, 787
Cedar (Eastern red cedar) *Juniperus virginiana*	890Q
Colorado spruce *Picea pungens*	886N, 787
Eastern red cedar (Cedar) *Juniperus virginiana*	890Q
Eastern white pine *Pinus strobus*	889A
Sitka spruce *Picea sitchensis*	787
Western red cedar *Thuja plicata*	787, 890Q

General Pollution (Con't)

TOLERANT - Shrubs

	Reference
Alder buckthorn *Rhamnus frangula*	886I
Alpine currant *Ribes sp.*	890Q
Blueberry *Vaccinium sp.*	407
Common lilac *Syringa vulgaris*	886K
Hedgerow rose *Rosa sp.*	890Q
Lilac *Syringa sp.*	890L, 890Q
Mentor barberry *Berberis mentorensis*	1501, 886I, 890Q
Spindletree *Euonymus sp.*	890L
Snowberry *Symphoricarpos albus*	890L
Sweetbriar *Rosa eglantaria*	890Q
Tatarian honeysuckle *Lonicera tatarica*	890L
Viburnum *Viburnum sp.*	890Q

TOLERANT - Herbaceous

Annual bluegrass *Poa annua*	407
Barley *Hordeum sp.*	407
Bean *Phaseolus*	407
Benoite *Geum sp.*	407
Blanketflower *Gaillardia sp.*	1513
Cabbage *Brassica napolerassica*	407
Cauliflower	407
Chickweed *Cerastium triviale*	38
Chrysanthemum *Chrysanthemum*	407
Corn *Zea mays*	407
Dandelion *Taraxacum platicardum*	38
Day lily *Hemerocallis fulva*	38
Hawksbeard *Crepis japonica*	38
Onion *Allium japonica*	38
Peas *Vigna sp.*	407
Pepper	407
Pink satin petunia *Petunia sp.*	797
Potatoes *Solanum jamesii*	407
Radish *Raphanus sp.*	407
Rhubarb *Rheum rhaponticum*	407
Roth *Athyrium nipponicum*	38
Siberian pea shrub	886K, 890
Spurge *Euphorbia helioscopia*	38
Spurge *Euphorbia sieboldiana*	38
St. Johnswort *Hypericum sp.*	407
Starwort *Stellaria media*	38
Strawberry *Fragaria sp.*	407
Tickseed *Coreopsis tinctoria*	38
Wheat *Triticum aestivum*	407
Woodbine *Lonicera periclymenum*	890Q
Wormwood *Artemis vulgaris*	38

INTERMEDIATE - Trees/Deciduous

Alder *Alnus sp.*	886C, 889A

General Pollution (Con't)

INTERMEDIATE - Trees/Deciduous

	Reference
American linden (Basswood) *Tilia americana*	886, 733
Apple *Malus sp.*	1332
Apricot *Prunus armeniaca*	407
Ash *Fraxinus bungeana*	38
Ash *Fraxinus longicuspis*	38
Aspen (Hybrid poplar) *Populus sp.*	886L, 890E, 886C
Balsam poplar *Populus balsamifera*	890E, 886L
Basswood (American linden) *Tilia americana*	886, 733
Black poplar *Populus nigra*	890E
Box elder *Acer negundo*	889A
Canoe birch (White birch) *Betula papyrifera*	886L, 890E
Chestnut oak *Quercus dentata*	38
Chokecherry *Prunus virginiana*	733
Elder *Sambucus*	886C
Elm *Ulmus sp.*	889A
English oak *Quercus robor*	886N
European larch *Larix decidua*	787, 886
Fig *Ficus carica*	733
Gladbearing oak *Quercus glandbearing*	38, 886C
Grapefruit *Citrus sp.*	407
Green ash *Fraxinus pennsylvanica var. lanceolata*	890E
Hawthorn *Crataegus*	886C, 733
Hornbeam *Carpinus sp.*	886C
Hybrid poplar (Aspen) *Populus sp.*	886L, 890E, 886C
Little leaf linden *Tilia cordata*	886N
Lombardy poplar *Populus nigra var. italica*	733
Maple *Acer sp.*	889A
Mountain ash *Sorbus americana*	890E
Mulberry *Morus sp.*	886C
Norway maple *Acer platanoides*	501
Pubescent birch *Betula sp.*	886N
Red ash *Fraxinus pennsylvanica*	886N, 501, 890L
Sawtooth oak *Quercus acuta*	38
Silver maple *Acer saccharinum*	501
Tulip poplar (Yellow poplar) *Liriodendron tulipifera*	501
Walnut *Juglans sp.*	407
White birch (Canoe birch) *Betula papyrifera*	886L, 890E
Willow *Salix sp.*	886C
Yellow poplar (Tulip poplar) *Liriodendron tulipifera*	501

INTERMEDIATE - Trees/Coniferous

Arborvitae *Thuja sp.*	889A
Canadian hemlock *Tsuga canadensis*	787
Colorado spruce *Picea pungens*	733
Eastern white pine *Pinus strobus*	886N, 787
Engelmann's spruce *Picea engelmanni*	889A
False cypress *Chameocyparis sp.*	889A
Fir *Abies sp.*	787
Japanese red pine *Pinus densiflora*	38
Lodgepole pine *Pinus contorta*	889A

General Pollution (Con't)

INTERMEDIATE - Coniferous

	Reference
Norway pine (Red pine) *Pinus resinosa*	886N
Pitch pine *Pinus rigida*	733
Red pine (Norway pine) *Pinus resinosa*	886N
Serbian spruce *Picea omorika*	889A

INTERMEDIATE - Shrubs

Common lilac *Syringa vulgaris*	890J
Filbert *Corylus sp.*	890L
Forsythia *Forsythia intermedia*	733, 501
Hedgerow rose *Rosa sp.*	890E
Japanese barberry *Berberis thunbergii*	890L
Juniper *Juniperus sp.*	889A
Spirea *Spirea sp.*	733
Tatarian honeysuckle *Lonicera tatarica*	501, 890J
Weigela *Weigela florida*	501

INTERMEDIATE - Herbaceous

Ageratum *Eupatorium coelestinum*	407
Bean *Phaseolus sp.*	407
Bluegrass *Poa matsumural*	38
Carnation *Dianthus sp.*	407
Celery *Spermolepsis sp.*	407
Chrysanthenum *Chrysanthenum sp.*	407
Common plantago *Plantago major*	38
Cudweed *Gnaphalium multiceps*	38
Daisy fleabane *Erigeron strigosus*	38
Endive *Cichorium endivia*	407
Grape *Vitis vinifera*	733
Groundsel *Senecio nikoensis*	38
Heat lettuce *Lactuca sp.*	407
Knotweed *Polygonum virginianum*	38
Lucerne *Medicago sativa*	407
Maidenhair *Adiantum pedatum*	38
Nasturtium (Yellow cress) *Nasturtium indicum*	38
Oat *Danthonia sp.*	407
Onion *Alliumsp.*	407
Petunia *Petunia sp.*	407
Rape seed (Turnip) *Brassica rapa*	407
Siberian pea tree	889A, 890J, 890L
Sorrel *Rumex acetosa*	38
Sudan grasses	407
Sweet coltsfoot *Petasites japonica*	38
Turnip (Rape seed) *Brassica rapa*	407
Violet *Viola sp.*	38
Yellow cress (Nasturtium) *Nasturtium indicum*	38
Zinnias *Heliopsis elegans*	407

General Pollution (Con't)

SENSITIVE - Trees/Deciduous

	Reference
Alder *Alnus multinervis*	38
Apple (Siberian crabapple) *Malus baccata*	886L, 311
Ash *Fraxinus sp.*	889A
Beech *Fagus sp.*	889A
Birch *Betula sp.*	886I, 311, 425
Black oak *Quercus velutina*	733
Box elder *Acer negundo*	890E
Buckeye *Aesculus turbinata*	38
Catalpa *Catalpa speciosa*	311, 425
Chestnut oak *Quercus prinus*	733
Chokecherry *Prunus virginiana*	733
Elm *Ulmus sp.*	811, 425, 1501
Japanese maple *Acer palmatum*	38, 425
Judas tree *Cercis siliquastrum*	1501
Larch *Larix sp.*	890K, 311, 38, 890E
Lichen	1490
Linden *Tilia sp.*	889A
Lombardy poplar *Populus nigra var. italica*	311, 425
Mahogany *Melia japonica*	38
Mulberry *Morus microphylla*	311
Oak *Quercus sp.*	425
Orange *Citrus sp.*	727
Peach *Prunus persica*	1332, 733
Pear *Pyrus communis*	311
Pumila Arborea (Turkestan elm) *Ulmus turkestanica*	890E
Siberian crabapple (Apple) *Malus baccata*	886L, 311
Tree of heaven *Ailanthus altissima*	1501
Turkestan elm (Pumila arborea) *Ulmus turkestanica*	890E
White oak *Quercus alba*	733
White poplar *Populus alba*	38
Wild black cherry *Prunus serotina*	1332

SENSITIVE - Trees/ Coniferous

Austrian pine *Pinus nigra*	733
Colorado spruce *Picea pungens*	733
Douglas fir *Pseudotsuga menziesii*	425, 733
Eastern white pine *Pinus strobus*	733, 311
Fir *Abies sp.*	890E, 886N, 886C, 889A
Norway spruce *Picea abies*	733
Ponderosa pine *Pinus ponderosa*	311
Scotch pine *Pinus sylvestris*	733, 886K, 890J, 787, 889A
Spruce *Picea sp.*	425, 889A, 886N, 39, 890E

General Pollution (Con't)

SENSITIVE - Shrubs

	Reference
Common lilac *Syringa vulgaris*	733
Oregon holly-grape *Mahonia aquifolium*	733
Yew *Taxus sp.*	889A

SENSITIVE - Herbaceous

Aconite *Aconitum japonicum*	38
Agrimony *Agrimonia pilosa*	38
Alfalfa *Medicago sativa*	727, 311
Aster *Aster bigelobii*	311
Bachelor's button *Centaurea cyanus*	311
Barley *Hordeum vulgare*	311
Bean *Phaseolus vulgaris*	311
Bedstraw *Galium strigosum*	
Beet *Beta vulgaris*	311, 407
Bindweed *Convolvulus arvensis*	311
Bluegrass *Poa sp.*	886C
Broccoli *Brassica oleraccea*	311
Brussel sprouts *Brassica aleracea var. gemmifera*	311
Buckwheat *Fagopyrum sagittatum*	311, 1332
Careless weed *Amaranthus palmeri*	311
Carrot *Daucus carota*	311
Catbriar *Smilax racemosa*	733
Chickweed *Stellaria media*	407
Cinquefoil *Potentilla chinensis*	38
Clover *Melilotus sp.*	311
Clover *Trifolium sp.*	311
Corn *Zea mays*	1332
Cosmos *Cosmos bipinnatus*	311
Cotton *Gossypium sp.*	311
Curly clock *Rumex crispus*	311
Endive *Cichorium endivia*	311
Fleabane *Erigeron canadensis*	311
Four o'clock *Mirabilis jalapa*	311
Galinsoga *Galinsoga parvifolia*	407
Goosefoot *Chenapodium album*	407
Green beans *Phaseolus sp.*	727
Gypsy petunia *Petunia sp.*	797
Horsetail *Equisetum arvense*	38
Huckleberry *Gaylussacia sp.*	733
Lettuce *Lactuca sativa*	311
Lettuce, prickly *Lactuca scariola*	311
Lima bean *Phaseolus limensis*	727
Mallow *Malva parvifolia*	311
Morning glory *Ipomoea purpurea*	311
Mosses *Commelina sp.*	1490
Oat *Avena sativa*	311
Okra *Hibiscus esculentus*	311
Pea *Vigna sinensis*	890K
Peanut *Arachis sp.*	727

General Pollution (Con't)

SENSITIVE - Herbaceous

	Reference
Pear tree	889A
Pepper bell, chili *Capsicum prutescens*	311
Pinto beans	727
Plantain *Plantago major*	311
Pumpkin *Cucurbita pepo*	311
Radish *Raphanus sativus*	311, 407
Ragweed *Ambrosia artemisifolia*	311
Rape seed (Turnip) *Brassica rapa*	311
Rhubarb *Rheum rhaponticum*	311
Rye *Secale cereale*	311
Solomon's seal *Polygonatum latifolium*	38
Sorrel *Rumex sp.*	407
Soybean *Glycine max.*	311, 727
Spinach *Spinacia oleracea*	727, 311, 407
Squash *Cucurbita maxima*	311
Sunflower *Helianthus*	311
Sweet corn	727
Sweet potato *Ipomoea batatas*	311
Swiss chard *Beta vulgaris var. cicla*	311, 407
Thistle *Cirsium inconiptum*	38
Tomato *Lycopersicium esculentum*	1332, 727
Turnip (Rape seed) *Brassica rapa*	311
Velvet-weed *Gaura parvifolia*	311
Vervain *Verbena canadensis*	311
Violet *Viola sp.*	311
Wheat *Triticum sp.*	311
Wild potato *Solanum jamesii*	727
Wood nettle *Laportea bulbifera*	38
Zinnia *Zinnia elegans*	311

TABLE IV-11

PLANT SPECIES SENSITIVITY LISTS

Hydrogen Chloride

	Reference
TOLERANT - Trees/deciduous	
Birch *Betula sp.*	536
Black Cherry *Prunus serotina*	536
Cherry *Prunus sp.*	886C
English walnut (Persian walnut) *Juglans regia*	886C
Maple *Acer sp.*	536
Oak *Quercus sp.*	536
Oleaster (Russian olive) *Eleagnus angustifolia*	536
Pear *Pyrus communis*	536
Persian walnut (English walnut) *Juglans regia*	886C
Red oak *Quercus borealis*	536
Russian olive (Oleaster) *Eleagnus angustifolia*	536
TOLERANT - Trees/Coniferous	
Arborvitae *Thuja sp.*	536
Austrian pine *Pinus nigra*	536, 1104
Balsam fir *Abies balsamea*	536
Canadian hemlock *Tsuga canadensis*	536
Eastern white pine *Pinus strobus*	536
Jack pine *Pinus banksiana*	536
Loblolly pine *Pinus taeda*	536
Norway spruce *Picea abies*	536
Short leaf pine *Pinus echinata*	536
TOLERANT - Shrub	
Yew *Taxus sp.*	536
TOLERANT - Herbaceous	
Carrot *Daucus carota*	187
Grapevine *Vitis sp.*	886C
INTERMEDIATE - Trees/Deciduous	
Black Cherry *Prunus serotina*	536
Black gum *Nyssa sylvatica*	536
INTERMEDIATE - Trees/ Coniferous	
Jack Pine *Pinus banksiana*	536
Short leaf pine *Pinus echinata*	536
SENSITIVE - Trees/Deciduous	
Apple *Malus sp.*	536
Box Elder *Acer negundo*	536
Cherry *Prunus sp.*	536
Horsechestnut *Aesculus hippocastanum*	536
Larch *Larix sp.*	536

Hydrogen Chloride (Con't)

SENSITIVE - Trees/Deciduous

	Reference
Pin oak *Quercus palustris*	536
Sassafras *Sassafras albidium*	536
Sugar maple *Acer saccharum*	536
Sweetgum *Liquidambar styraciflua*	536
Tree of heaven *Ailanthus altissima*	536

TABLE IV-12

PLANT SPECIES SENSITIVITY LISTS

Nitrogen Dioxide

	Reference
TOLERANT - Trees/Deciduous	
Beech *Fagus sp.*	16
Gingko (Maidenhair tree) *Gingko biloba*	16
Maidenhair tree (Gingko) *Gingko biloba*	16
Oak *Quercus sp.*	16
TOLERANT - Trees/Evergreen	
Austrian pine *Pinus nigra*	16
TOLERANT - Herbaceous	
Cabbage *Brassica sp.*	16
Gladiolus	16
Onion *Allium sp.*	16
INTERMEDIATE - Trees/Evergreen	
European larch *Larix decidua*	536
SENSITIVE - Trees/Deciduous	
Apple *Malus sp.*	536
Black locust *Robinia pseudoacacia*	536
European beech *Fagus sylvatica*	536
European hornbeam *Carpinus betulus*	536
European red elder *Sambucus racemosa*	536
Gingko (Maidenhair tree) *Gingko biloba*	536
Japanese maple *Acer palmatum*	536
Large leaf linden *Tilia grandiflora*	536
Little leaf linden *Tilia cordata*	536
Maidenhair tree (Gingko) *Gingko biloba*	536
Norwary maple *Acer platanoides*	536
Pear *Pyrus communis*	536
SENSITIVE - Trees/Evergreen	
Austrian pine *Pinus nigra*	536
Colorado spruce *Picea pungens*	536
Eastern white pine *Pinus strobus*	536
White spruce *Picea glauca*	536
SENSITIVE - Shrubs	
Dwarf mugo pine *Pinus mugo mughus*	536
SENSITIVE - Herbaceous	
Barley *Hordeum sp.*	16
Begonia *Rumex sp.*	16
Carrot *Daucus carota*	16
Kidney beans *Phaseolus sp.*	16

Nitrogen Dioxide (Con't)

SENSITIVE - Herbaceous

	Reference
Lettuce *Lactuca sp.*	1849, 16
Red clover *Trifolium pratense*	16
Sweat peas *Lathyrus odoratus*	16
Tobacco *Nicotiana sp.*	16

TABLE IV-13

PLANT SPECIES SENSITIVITY LISTS

Ozone

TOLERANT - Trees/Deciduous

	Reference
Acacia *Acacia sp.*	181
Alder *Alnus sp.*	1164
American sycamore *Platanus occidentalis*	1074, 1164, 990
Ash *Fraxinus sp.*	181
Basswood (Linden) *Tilia sp.*	1137
Black walnut *Juglans nigra*	1164, 536
English oak *Quercus robor*	536, 1164
European mountain ash *Sorbus aucuparia*	536
European white birch *Betula pendula*	536, 1164
Fig *Ficus carica*	181
Flowering dogwood *Cornus florida*	536, 1164
Giant sequoia *Sequoia gigantea*	536
Linden (Basswood) *Tilia sp.*	1137
Little leaf linden *Tilia cordata*	1164
Maidenhair tree *Gingko biloba*	181
Norway maple *Acer platanoides*	536, 1164
Plum *Prunus sp.*	181
Red maple *Acer rubrum*	536, 1164
Red oak *Quercus borealis*	1164
Redwood *Sequoia sempervirens*	536
Shingle oak *Quercus imbricaria*	536. 1164
Sugar maple *Acer saccharum*	536, 1137
Weeping willow *Salix babylonica*	1164
White birch *Betula papyrifera*	1137

TOLERANT - Trees/ Coniferous

Arborvitae *Thuja sp.*	774, 1164, 536
Balsam fir *Abies balsamea*	1137, 536, 1164, 774
Black hills spruce *Picea glauca densata*	774, 1164, 536, 1137
Colorado spruce *Picea pungens*	1137, 536, 1164, 774
Digger pine *Pinus sabiniana*	536
Douglas fir *Pseudotsuga menziesii*	774, 1137, 536, 1164
Eastern red cedar *Juniperus virginiana*	181
Jack pine *Pinus banksiana*	1074
Norway pine (Red pine) *Pinus resinosa*	1137, 1164, 774, 536
Norway spruce *Picea abies*	1137, 774, 1164, 536
Red pine (Norway pine) *Pinus resinosa*	1137, 1164, 774, 536
Singleleaf pinyon pine *Pinus monophylla*	536
Sugar pine *Pinus lambertiana*	536
Torrey pine *Pinus torreyana*	536
Virginia pine *Pinus virginiana*	1074
White fir *Abies concolor*	774, 1164, 1137
White spruce *Picea glauca*	536, 1164

TOLERANT - Shrubs

Ivy *Hedera sp.*	181

TOLERANT - Herbaceous

Bugleweed (Carpet bugle) *Ajuga sp.*	181

Ozone (Con't)

	Reference
TOLERANT - Herbaceous	
California poppy *Eschscholtzia california*	181
Carpet bugle (Bugleweed) *Ajuga sp.*	181
Lady's slipper *Cypripedium sp.*	181
Leadwort *Ceratostigma plumbaginoides*	181
Petunia *Petunia sp.*	1015, 1074
INTERMEDIATE - Trees/ Coniferous	
Big cone Douglas fir *Pseudotsuga macrocarpa*	536
Coulter pine *Pinus coulteri*	536
California: Incense-cedar *Libocedrus decurrens*	536
White fir *Abies concolor*	536
SENSITIVE - Trees/Deciduous	
Alder *Alnus sp.*	536
American elm *Ulmus americana*	1164
American sycamore *Platanus occidentalis*	1074
Black locust *Robinia pseudoacacia*	1164, 536
Boxelder *Acer negundo*	536, 1164
California sycamore *Platanus racemosa*	1074
Catalpa *Catalpa speciosa*	1164
European larch *Larix decidua*	990, 1164, 1137, 536
Gambel oak *Quercus gambellii*	1164, 536
Green ash *Fraxinus pennsylvanica lanceolata*	536, 1164
Honeylocust *Gleditsia triacanthos*	1164, 536
Hybrid poplar *Populus sp.*	--
Japanese larch *Larix leptolepsis*	1164, 536, 77
Judas tree *Cercis siliquastrum*	536
Little leaf linden *Tilia cordata*	536
Mapleleaf mulberry (White mulberry) *Morus alba*	536
Pin oak *Quercus palustris*	536, 1164
Quaking aspen *Populus tremuloides*	536, 1164
Scarlet oak *Quercus coccinea*	1164, 536
Siberian crab apple *Malus baccata*	536, 1164
Silver maple *Acer saccharinum*	536, 1164
Sweetgum *Liquidambar styraciflua*	1164, 536
Thornless honeylocust *Gleditsia triacanthos inermis*	1074
Tulip poplar (Yellow poplar) *Liriodendron tulipifera*	990,1164,536,1074,1137
Weeping willow *Salix babylonica*	536
White ash *Fraxinus americana*	990,1137,1074,536,1164
White mulberry (Mapleleaf mulberry) *Morus alba*	536
White oak *Quercus alba*	1164, 536, 1137
Yellow poplar (Tulip poplar) *Liriodendron tulipifera*	990,1164,536,1074,1137
SENSITIVE - Trees/ Coniferous	
Austrian pine *Pinus nigra*	1164, 536, 774, 1137

Ozone (Con't)

SENSITIVE - Trees/ Coniferous

	Reference
Canadian hemlock *Tsuga canadensis*	536, 1137
Eastern white pine *Pinus strobus*	536, 774, 1137, 532 990, 1164
Jack pine *Pinus banksiana*	774, 536, 1164
Jeffery pine *Pinus jeffreyi*	536
Monterey pine *Pinus radiata*	536
Pitch pine *Pinus rigida*	1164, 1135, 774, 536
Ponderosa pine *Pinus ponderosa*	536
Scotch pine *Pinus sylvestris*	774, 536, 990
Virginia pine *Pinus virginiana*	536, 774, 1137

SENSITIVE - Shrubs

Bridal wreath spirea *Spirea prunifolia*	1164
Camellia *Camelia sp.*	2
Common lilac *Syringa vulgaris*	990, 1164
Common privet *Ligustrum vulgare*	1164
Snowberry *Symphoricarpos albus*	536

SENSITIVE - Herbaceous

Aster *Aster sp.*	990
Sage *Salvia sp.*	990
Tobacco *Nicotiana sp.*	599

TABLE IV-14

PLANT SPECIES SENSITIVITY LISTS

Pan

	Reference
TOLERANT - Trees/Deciduous	
European larch *Larix decidua*	536
Japanese larch *Larix leptolepsis*	536
Sugar maple *Acer saccharum*	536
TOLERANT - Trees/ Coniferous	
Austrian pine *Pinus nigra*	536
Canadian hemlock *Tsuga canadensis*	536
Colorado spruce *Picea pungens*	536
Eastern white pine *Pinus strobus*	536
Jack pine *Pinus banksiana*	536
Pitch pine *Pinus rigida*	536
White spruce *Picea glauca*	536
SENSITIVE - Trees/Deciduous	
Little leaf linden *Tilia cordata*	536
Tulip poplar (Yellow poplar) *Liriodendron tulipifera*	536
Yellow poplar (Tulip poplar) *Liriodendron tulipifera*	536
SENSITIVE - Herbaceous	
Aster *Aster sp.*	990
Chrysanthemum *Chrysanthemum sp.*	990
Lettuce *Lactuca sp.*	1849
Petunia *Petunia sp.*	990
Primrose *Primula sp.*	990
Sage *Salvia sp.*	990
Snapdragon *Chaenorrhinum sp.*	990

TABLE IV-15

PLANT SPECIES SENSITIVITY LISTS

Particulates - Smoke

	Reference
TOLERANT - Trees/Deciduous	
American Elm *Ulmus americana*	547
European larch *Larix decidua*	1604
Scarlet elder *Sambucus pubens*	1390
TOLERANT - Shrub	
Cranberry *Vaccinium sp.*	187
TOLERANT - Herbaceous	
Knotweed *Polygonum cilinode*	1390
INTERMEDIATE - Trees/Deciduous	
Alder *Alnus sp.*	1604
American beech (Red beech) *Fagus grandifolia*	1604
American hornbeam *Carpinus caroliniana*	1604
Birch *Betula sp.*	1604
English oak *Quercus robor (formerly called penduculata)*	1604
Maple *Acer sp.*	1604
Poplar *Populus sp.*	1604
Raceme oak *Quercus racemosa*	1604
Red beech (American beech) *Fagus grandifolia*	1604
Red oak *Quercus borealis*	1604
White alder *Alnus rhombifolia*	1604
INTERMEDIATE - Trees/ Coniferous	
Austrian Pine *Pinus nigra*	1604
Eastern white pine *Pinus strobus*	1604
Scotch pine *Pinus sylvestris*	1604
SENSITIVE -Trees/Deciduous	
Quaking aspen *Populus tremuloides*	1390
Single-seeded hawthorne *Crataegus monogyna*	1675
SENSITIVE - Trees/Coniferous	
Black Spruce *Picea mariana*	1390
Eastern white pine *Pinus strobus*	1390
Fir *Abies sp.*	1604
Norway spruce *Picea abies (excelsa)*	1604
White spruce *Picea glauca*	1390
SENSITIVE - Herbaceous	
Annual bluegrass *Poa annua*	269

TABLE IV- 16

PLANT SPECIES SENSITIVITY LISTS

Sulfur Dioxide

TOLERANT - Trees/Deciduous

	Reference
American sycamore *Platanus occidentalis*	1164
Ash *Fraxinus sp.*	886C
Basswood (Linden) *Tilia sp.*	369
Beech *Fagus sp.*	1187, 886C
Birch *Betula sp.*	64, 523, 1187
Black gum *Nyssa sylvatica*	1169, 536
Black locust *Robinia pseudoacacia*	536
Cottonwood (Eastern poplar) *Populus deltoides*	1164, 536
Eastern poplar (Cottonwood) *Populus deltoides*	1164, 536
English oak *Quercus robor*	1164, 536
European ash *Fraxinus excelsior*	369
European beech *Fagus sylvatica*	536
European hornbeam *Carpinus betulus*	536
European mountain ash *Sorbus aucuparia*	369
Flowering dogwood *Cornus florida*	1164, 536
Gingko (Maidenhair tree) *Gingko biloba*	1164, 369
Green ash *Fraxinus pennsylvanica lanceolata*	536, 1164
Hedge maple *Acer campestre*	536, 1164
Hornbeam *Carpinus sp.*	1187
Larch *Larix sp.*	44
Linden (Basswood) *Tilia sp.*	369
Maidenhair tree (Gingko) *Gingko biloba*	1164, 369
Mountain maple *Acer spicatum*	1164
Oak *Quercus sp.*	44
Oriental plane tree *Platanus orientalis*	1164
Persian walnut *Juglans regia*	886C
Pin oak *Quercus palustris*	1164
Poplar *Populus sp.*	369
Red berried elder *Sambucus pubescens*	1074
Red maple *Acer rubrum*	536, 1164
Red oak *Quercus borealis*	1164, 44
Smooth elm *Ulmus glabra*	369
Sourwood *Oxydendrum arboreum*	369
Sugar maple *Acer saccharum*	1164
Tulip poplar (Yellow poplar) *Liriodendron tulipifera*	16, 1164, 369
White ash *Fraxinus americana*	138
Willow *Salix sp.*	369
Yellow poplar (Tulip poplar) *Liriodendron tulipifera*	16, 1164, 369

TOLERANT - Trees/ Coniferous

Arborvitae *Thuja occidentalis*	1164
Austrian pine *Pinus nigra*	525, 1164, 536
Canadian hemlock *Tsuga canadensis*	1074
English holly *Ilex aquifolium*	1164, 536
Lawson false cypress *Chamaecyparis lawsoniana*	536
Spruce *Picea sp.*	886C
Western red cedar *Thuja plicata*	1164
White spruce *Picea glauca*	1164

Sulfur Dioxide (Con't)

	Reference
TOLERANT - Shrubs	
Dwarf mugo pine *Pinus mugo mughus*	536
Juniper *Juniperus sp.*	1164, 536
TOLERANT - Herbaceous	
Alfalfa *Medicago sativa*	886C
Corn *Zea mays*	16
Fringed bindweed *Polygonum cilinode*	1074
Galleta *Hilaria jamesii*	1365
Grama grass *Bouteloua barbata*	1365
Heliotrope *Heliotropium sp.*	886C
Meadow fescue *Festuca elatior*	136
Oats *Avena sp.*	886C
Orchard grass *Dactilus glomerada*	136
Primrose *Primula sp.*	886C
Sweetpea *Lathyrus odoratus*	886C
Woodwaxen	886C
INTERMEDIATE - Trees/Deciduous	
Apple *Malus sp.*	16
Apricot *Prunus armeniaca*	16
Balsam poplar *Populus balsamifera*	1164, 536
Bigtooth aspen *Populus grandidentata*	1164
Norway maple *Acer platanoides*	1164
INTERMEDIATE - Trees/ Coniferous	
Balsam fir *Abies balsamea*	536, 1164, 525
Douglas fir *Pseudotsuga menziesii*	1164, 525, 536
Lodgepole pine *Pinus contorta*	536, 525
Scotch pine *Pinus sylvestris*	1164
Silver fir *Abies pectinata*	536
INTERMEDIATE - Shrubs	
Rose *Rosa sp.*	16
INTERMEDIATE - Herbaceous	
Gladiolus	16
Cotton *Gossypium sp.*	16
Iris *Iris sp.*	16
SENSITIVE - Trees/Deciduous	
Alder *Alnus*	119, 732
American elm *Ulmus americana*	1164
American sycamore *Platanus occidentalis*	1164
Apple *Malus sp.*	1164

Sulfur Dioxide (Con't)

SENSITIVE - Trees/Deciduous

	Reference
Aspen (Poplar) *Populus sp.*	732, 1187
Birch *Betula sp.*	1164, 1119
Blueberry elder *Sambucus coerulea*	732
Canoe birch (White birch) *Betula papyrifera*	732
Catalpa *Catalpa speciosa*	1164
Cherry *Prunus sp.*	732
Chokecherry *Prunus virginiana*	938
English walnut (Persian walnut) *Juglans regia*	1164
European mountain ash *Sorbus aucuparia*	732, 1187
Horse chestnut *Aesculus hippocastanum*	44
Hornbeam *Carpinus sp.*	44
Larch *Larix sp.*	732, 1164
Lombardy poplar *Populus nigra var. italica*	1164
Maple *Acer sp.*	1187
Mazzard cherry *Prunus avium*	886C
Mountain ash *Sorbus americana*	1164
Mountain maple *Acer spicatum*	44
Narrowleaf cottonwood *Populus angustifolia*	1365
Pear *Pyrus communis*	1164
Persian walnut (English walnut) *Juglans regia*	1164
Poplar (Aspen) *Populus sp.*	732, 1187
Quaking aspen *Populus tremuloides*	1164, 119
Scarlet hawthorn *Crataegus oxyacantha*	990
Serviceberry *Amelanchier sp.*	1164
Texas mulberry *Morus microphylla*	1164
Utah serviceberry *Amelanchier utahensis*	1164
White ash *Fraxinus americana*	773
White birch (Canoe birch) *Betula papyrifera*	732
Willow *Salix sp.*	1164, 732

SENSITIVE - Trees/Coniferous

Black spruce *Picea mariana*	1164
Canadian hemlock *Tsuga canadensis*	1164
Douglas fir *Pseudotsuga menziesii*	990
Eastern white pine *Pinus strobus*	990, 1164, 1074, 563,732,773,119
Engelman's spruce *Picea engelmannii*	1164
Fir *Abies sp.*	119
Jack pine *Pinus banksiana*	1164
Mountain hemlock *Tsuga mertensiana*	1164
Norway pine (Red pine) *Pinus resinosa*	16
Ponderosa pine *Pinus ponderosa*	1164, 1007
Red pine (Norway pine) *Pinus resinosa*	16
Scotch pine *Pinus sylvestris*	1074, 525
Sitka spruce *Picea sitchensis*	732
Virginia pine *Pinus virginiana*	773
Western red cedar *Thuja plicata*	1074
Western white pine *Pinus monticola*	1164

Sulfur Dioxide (Con't)

SENSITIVE - Shrubs

	Reference
Mountain laurel *Kalmia latifolia*	1164
Ninebark *Physocarpus capitatus*	1164
Snowberry *Symphoricarpos aerophilus*	1365
Wild rose *Rosa woodsii*	1365

SENSITIVE - Herbaceous

Alfalfa *Medicago sativa*	938, 732
Begonia *Rumex venosus*	990, 1009
Buckwheat *Fagopyrum sp.*	16
Celery *Spermolepsis sp.*	16
Cotton *Gossypium sp.*	16
Cucumber *Sicyos angulatus*	16
Eggplant *Solanum melongena*	16
Evening primrose *Oenothera sp.*	1365
Geranium *Geranium*	16
Globe mallow *Sphaeralcea munroana*	1365
Goosefoot *Chenopodium ofrenonti*	1365
Grape *Vitis sp.*	938
Hound's tongue *Cynoglossum officinale*	1365
Hungarian brome *Bromus inpermis*	136
Indian rice grass *Oryzopsis hymenoides*	1365
Lettuce *Lactuca sp.*	1844
Locoweed *Astragalus utahensis*	1365
Lucerne *Medicago sativa*	1007
Petunia *Petunia sp.*	1009
Potato *Solanum tuberosum*	1007
Red clover *Trifolium pratense*	136
Scarlet Gilia *Gilia agregata*	1365
Squash *Cucurbita sp.*	938
Sunflower *Helianthus sp.*	886C
Sweet clover *Melilotus sp.*	732, 16
Tobacco *Nicotiana sp.*	16
Vervain *Verbena sp.*	990
Violet *Viola sp.*	990
Wheat *Triticum aestivum*	1007

TABLE OF CONTENTS

IV PLANT SPECIES SENSITIVITY LISTS IV-1

Scientific Name IV-2

Common Name IV-24

V LITERATURE ABSTRACTS V-1

LITERATURE ABSTRACTS

In Alphabetical Order by First Author's Last Name

The following abstracts are presented in alphabetical order by first author's last name. An indexing number appears immediately above the author's name. It also appears in the tables and elsewhere in the text of these volumes when the literature is specifically cited. A listing of the abstract titles in numerical order follows this list in Subsection B of this section.

The last line of each abstract contains a source number which refers to the location from which the subject abstract was located and retrieved. The key to those numbers is as follows:

1. APTIC
2. CAIN
3. DATRIX
4. DDC
5. Bibliography taken from another citation
6. Dr. Dochinger's Library (See Volume I)
7. Dr. Smith's Library (See Volume I)
8. COMSIS CORPORATION Library

The numbers preceeding each title refers to the approximate chronological order in which the abstracts were prepared. They correspond to the reference numbers appearing in the text of Volume I. An occasional number is vacant in this chronological order because some articles were found to duplicate others.

#79
Abeles, F.B., L.E. Craker, L.E. Forrence and G.R. Leather. "Fate of air pollutants: removal of ethylene, SO_2, and NO_2 by soil." Science, 173: 914-916 (1971).

The ultimate sink for many air pollutants is unknown. Data are presented here in support of the idea that reaction with soil, through microbial or chemical means, can remove ethylene, other hydrocarbons, SO_2 and NO_2 from the air.
Source: 7, 6

#544
Abeles, F.B., and H.E. Heggestad. "Ethylene: An urban air pollutant." J. Air Pollut. Control Assoc., 23(6):517-521 (June 1973).

Ethylene is an unusual air pollutant in that it is a plant hormone. Motor vehicle exhaust is a primary source. In the Washington, D. C. area, ethylene concentrations ranged from 700 ppb in the city center to 39 ppb in areas outside the circumferential beltway. Plants grown in these concentrations of ethylene, using controlled environment chambers, exhibited typical symptoms of ethylene toxicity: reduced growth, premature senescence, and reduced flowering and fruit production. When plants were grown in carbon-filtered ambient air, which was also filtered through $KMnO_4$ to remove ethylene by oxidation, growth, flowering, and fruit production increased. These observations demonstrate that ethylene air pollution is a continual source of stress for plant growth and development in an urban environment.
Source: 2

#1957
Abramashvili, G. G. "The effect of atmospheric air pollution on coniferous plantings." Translated from Russian. U.S.S.R. Literature on Air Pollution and Related Occupational Diseases, 1: 75-78 (January 1960). (Also published in Gigiena i Sanit., No. 67-69, 1957.)

In recent years there has been noticed a general trend to use coniferous trees in the landscaping of gardens, parks, boulevards, and residence grounds. This trend gained impetus due to the fact that in the northern part of the U.S.S.R. leafy trees remain bare during 6-7 months of the year, whereas the evergreen coniferous tree varieties act as purifiers of atmospheric air from dust and gaseous pollution. It was demonstrated that coniferous tree varieties possess the property of first adsorbing and then absorbing via the stoma and leaf openings such city street gases as SO_2 and SO_3 and accumulating them to varying degrees. Analysis of coniferous needles collected at different points of Moscow showed that the sulfate content which spruce tree needles can tolerate without any notable ill effect ranged between 0.5-0.85% on the dry basis. The results of these studies indicated that coniferous species, especially the prickly spruce, are useful city landscape decorating agents and can play an important part in the sanitary improvement of urban environment.
Source: 1

#278

Abramov, R. V. "Pyl v atmosfere nad Atlanticheskim Okeane." [Dust in the atmosphere over the Atlantic Ocean]. Izd. Nauka Moskva, 1971:7-30 (1972).

Sources and modes of transport of natural dust deposited over the Atlantic Ocean, mostly north of the equator, are reviewed. Participation of the atmosphere in recent sedimentation on the bottom of oceans is beyond doubt, although its role in transporting material of various origin is not clear. The active role of atmospheric processes is clear in the case of eolian deposits, and atmospheric influences are a major factor in erosion. The turbulence of atmospheric movements increases the quantity of comminuted material removed from land surfaces; air currents transport dust over large distances; and descending air currents and atmospheric precipitation, to a certain extent, facilitate dustfall over the oceans. Material such as volcanic dust is transported by the atmosphere with the possibility of appreciable alterations in the basic parameters of atmospheric circulation. The atmosphere may be regarded as a passive medium, damping the meteoric particles, in the case of cosmic dust.
Source: 1

#748

Adamowicz, S. "Waldumbau im oberschlesischen industriebezirk." (Change in afforestation of the Upper Silesian industrial basin). Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemslowego, Mater. Miedzynarodowej Knof., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p. 389-406 (Sept. 9-14, 1968).

Woods in the Upper Silesian industrial basin cover an area of 69,677 ha. The vegetation period extends over 210-200 days, the median yearly temperature is 7-8 C and the annual rainfall 646-732 mm. The degree of damage to these woods depends on their composition, distance from a source of pollution, nature and concentration of the pollutants, and on-site conditions. Contributing factor include changes in water balance caused by mining operations and morphologic surface changes (cave-ins and surface mining). Hydrologic changes contribute to reduced growth gains, lower biological resistance, and deterioration of tree stands. Of the entire wooded area 30,639 ha suffered slight damage, 20,171 ha suffered medium damage, and 5974 ha suffered severe damage, and the deterioration is increasing at an alarming rate. Of the wooded area 8172 ha of the stands are less than 20 years old, 25,343 ha are less than 60 years old, and 23,269 ha are over 60 years old; 17,092 ha are conifers, 34,851 ha are mixed woods, and 4841 ha are deciduous woods. Guidelines governing planning designed to raise the species are outlined, including replacement of spruce and pine stands with Larix europaea, Pinus nigra, Pseodotsuga doug, Quercus ruber, Q. pedunenculata, and other resistant species.
Source: 1

#747
Adams, D. F. "The effects of air pollution on plant life." (Presented at the American Industrial Hygiene Association, Annual Meeting, 17th, Philadelphia, Pa., April 23-27, 1956.) A.M.A. Arch.Ind. Health, 14:229-245 (July-December 1956).

Knowledge of the range of foliar expressions of plants exposed to atmospheric pollutants is extremely useful to those engaged in the study of the scope and severity of an air-pollution problem. The wide variations in susceptibility and characteristic response of common species to typical contaminants provide a convenient method for identifying, determining the distribution of, estimating the level of, and providing a collection medium for subsequent chemical analysis for a pollutant. A detailed review of the progress of research on the effects of sulfur dioxide, hydrogen fluoride, and 'Los Angeles-type' smog since 1950 is presented (with work published prior to 1950 cited to provide continuity whenever necessary). Fluoride appears to be a cumulative phytotoxicant which may move through the plant vascular system to the leaf tip or margin and produce foliar necrosis upon accumulation of a 'threshold concentration.' Evidence also points toward possible enzymatic inhibition. Sulfur dioxide and smog exposures result in foliar injury only if the rate of tissue absorption exceeds the rate at which the plant can effectively neutralize the toxic agent. Smog, however, can produce growth inhibition without producing visible injury, whereas sulfur dioxide does not produce this so-called invisible injury. Reference is made to a catalogue of common weeds according to their characteristic foliar response and susceptibility to a number of pollutants.
Source: 1

#1009
Adedipe, N. O., R. E. Barrett, and D. P. Ormrod. "Phytotoxicity and growth responses or ornamental bedding plants to ozone and sulfur dioxide." J. Amer. Soc. Hort. Sci., 97(3):341-345 (1972).

No appreciable signs of phytotoxicity were observed for 4 days following fumigation of plants including begonis, petunias, and snapdragons with ozone up to 80 pphm or sulfur dioxide up to 400 pphm for 2 hr. Thereafter, there was considerable necrosis, particularly on begonias fumigated with the highest concentration of the pollutants. Growth suppression was reflected in reduced shoot and flower weight, and to a lesser degree in reduced flower number. Overall, begonias and petunias were the most sensitive. Coleus and snapdragons were moderately sensitive, while marigold, celosia, impatiens, and salvia were tolerant. White Tausendschon was the most sensitive begonia cultivar, while blue-flowered Capri was the most sensitive petunia. Mixed color petunias exhibited varying degrees of tolerance. Scarlet Rainbow coleus was more sensitive than Pastel Rainbow. Measurements of growth alterations in plants were very useful in determining latent forms of air pollutant injury.
Source: 1

#1008

Adedipe, N.O., R.A. Fletcher, and D.P. Ormrod. "Ozone lesions in relation to senescence of attached and detached leaves of tobacco." Atmos. Environ., 7(3):357-361 (March 1973).

Leaf discs, detached leaves, and attached leaves of 60-day old tobacco plants were fumigate with ozone at 30 pphm for 2 hours to determine whether O_3 induced localized yellowing of leaves is physiologically related to normal leaf senescence and the magnitude of visual and physiological manifestations of O_3 injur . In a ssnsitive cultivar, O_3 lesions were minimal on leaf discs, moderate on detached leaves, and severe on attached leaves. The O_3 decreased the chlorophyll content by 26, 31, and 48%, respectively, in the leaves, but increased protein and RNA content only in detached leaves. Localized yellowing caused by O_3 was not consistently accompanied by parallel and concomitant declines in chlorphyll protein, and RNA which are characteristic of normal leaf sensescence.
Source: 1

#415

Aichi Prefectural Government (Japan). "Kogai no jokyo ni kansuru nenji hokoku kankyo hakusho, Showa 47 nendo." (Annual report on the state of environmental pollution - environmental white paper, 1972). Text in Japanese. 355 p., (October 1973).

The overall state of pollution damages inflicted on natural environment, plants, animals, and birds was investigated in 1972 by 60 schools in the prefecture. In the Nagoya area, tree mosses especially are investigated as an air pollution indicators. At 203 locations of Nagoya, mosses grew at 128 locations, and 37% lacked the moss growth, especially in south and southwest Nagoya. Other indicators are dragon flies and butterflies, which are drastically decreasing in number, and fireflies, which are specially protected, and certain rare wild plants. The total number of wild animals and birds has not changed much in recent years; but the species and locations show quite a change due to the development of industrial areas and intensive use of land; there is a definite tendency for an overall decrease of wildlife. Plans and programs for the protection of natural environment, further investigations, designation of natural reserves, promotion of vegetation, maintenance of parks and forests, and protection of natural life in general are discussed.
Source: 1

#1010
Akaiwa, K and M. Shinozaki. "Yugai gasu ni yoru shokubutsu higai no kaiseki (I) -f. jumoku no taisuru ozon. aryusan gasu no eikyo shiken." (Analyses of plant injuries due to harmful gases: Part I. Sec. F. Experiments on the effects of ozone and sulfur dioxide on several trees). Kanagawa-ken Nogyo Sogo Kenkyujo Gyomu Nenpo (Ann. Rep. Kanagawa Prefect. Agr. Integr. Inst.), 1973:73 (June 1974).

Seedlings of a cultivar of Rhododendron, Pasania edulis, Gardenia jasmoides grandiflora, Populus nigra, Hydrangea, Zelkova serrata, Syringa vulgaris, a species of acacia, and Magnolia liliflora were exposed to ozone at 0.2 ppm, sulfur dioxide at 1 ppm, first ozone then sulfur dioxide, and sulfur dioxide and then ozone at 0.13 ppm. The daily period of exposure was 5 hr. The time of exposure necessary for causing visible injury at 0.2 ppm of ozone was 11 hr for Populus nigra, 15 hr for Acacia, and 21 hr for Hydrangea. No visible injury was observed on Zelkova serrata, and Magnolia liliflora respectively exposed for 36 and 26 hr. The visible injury after exposure to sulfur dioxide at 1 ppm for 10 hr was most conspicuous on Populus nigra, and Syringa vulgaris, followed by Zelkova serrata, Magnolia liliflora, Hydrangea, Rhodendron, and Pasania edulis. No difference of visible injuries was found on trees exposed to ozone and then SO2 and those exposed to SO2 and then O3.
Source: 1

#1150
Aldaz, L. "Flux measurements of atmospheric ozone over land and water." J. Geophys. Res., 74(28):6943-6946 (1969).

Using the new 'box' method, it has been determined that the downward flux of atmospheric ozone over New Mexico soil averages 3×10^{11} molecules/cm^2 sec, and over the Atlantic Ocean averages 0.2×10^{11} molecules/cm^2 sec. Estimates for the global ozone sink range from 5.4 to 8.6×10^{24} ozone molecules/sec, or 1.3 to 2.1×10^{9} tons of ozone per year.
Source: 5

#160
Alexander, M. "Microorganisms and chemical pollution." BioScience, 23(9):509-515 (September 1973).

Microorganisms such as algae, bacteria, fungi, and protozoa and unquestionably important in chemical pollution and pollution abatement since they are environmental decontaminating agents per excellence and can also be significant in synthesizing hazardous substances from reasonably innocuous Precursors, Heterotrophs and a few algal species are known to generate, oxidize or reduce volatile pollutants in axenic culture; and limited data suggest a substantial role for certain populations in the evolution or removal of carbon monoxide, hydrocarbons, and other volatile organics, as well as nitrogen and sulfur compounds. Reports that bacteria and algae can oxidize CO to carbon dioxide in culture and that methanogenic bacteria reduce it to methane have a direct relevance to the CO balance in nature. Volatile hydrocarbons are subject to microbiologically controlled cyclings also with the evolution in anaerobic habitats of propane, butene, non-2-ene, dec-2-ene, heptan-2-one,

octan-2-one, and nonan-2-one. Moreover, assays of gas evolution from many natural habitats have disclosed that various oxides of nitrogen are liberated during the reduction of nitrate in bacterial denitrification. Microbial contribution to the formation or destruction of sulfur compounds in the atmosphere has also been established recently.
Source: 1

#1939
Allen, L. H., et al. "Plant responses to CO_2 enrichment under field conditions -A simulation." Science, 173(3993):256-258 (July 16 1971)

A comprehensive soil-plant-atmosphere computer simulation model (SPAM) predicted up to a 45% increase in carbon dioxide uptake by a crop enriched with CO_2 at ground level. Enrichment rates of 225 and 450 kg/CO_2/ha/hr were used. The simulations covered a wide range of wind speed, crop height, and leaf display area. Efficiency of uptake, i. e., the increased CO_2 uptake divided by total added CO_2, was never greater than 10% and only about two percent for tall, open vegetation with normal leaf display at high wind speeds. Carbon dioxide enrichment under normal field conditions would be very inefficient because of the rapid loss of added CO_2 to the atmosphere and the resulting small buildup of CO_2 near the leaves of the top canopy where most light is available.
Source: 1

#123
American Forest Institute. "Forests U. S. A." 1619 Massachusetts Avenue, N. W. Washington, D. C., p. 10 (July 1974).

Short article with few facts:

- an average acre of young trees in a commercial forest consumes 5-6 tons CO_2/yr, gives off 4 tons O_2/yr and produces 4 tons of new wood.

- net cooling effect of young tree = 10 room-sized air conditioners operating 20 hrs/day.

Source: 7

#1076
American Soc. of Mech. Eng. Recommended guide for prediction of dispersion of airborne effluents. Amer. Soc. Mech. Eng., United Eng. Cntr., New York, 85 p. (1968).

This guide has been prepared to provide a review of the important aspects of atmospheric dispersion and to assist in the practical assessment of typical industrial problems. It is intended as a first approximation of simple situations in uncomplicated terrain, and it would be difficult to over-emphasize the danger of being misled by improper application of the equations presented. It is important to remember that many of the contributors are not fully convinced that current understanding of dispersion problems justifies the preparation of a simplified approach, and the user is cautioned to seek qualified advice wherever these first approximations indicate a problem, or wherever the environment appears to be complex.

The emphasis is on ordinary, continuous stack emissions, and while other problems may be mentioned, none are treated fully. Similarly there has been no attempt to reference every significant work in the field of atmospheric dispersion; rather the bibliography contains material that should promote general understanding and lead to additional sources of information.

The techniques suggested for the quantitative approximation of air pollution problems represent the most suitable now available. It should be stressed, however, that this is a rapidly-developing specialty, and that some of the recommended procedures will most certainly be superseded.
Source: 8

#1011
Amirev, R. O., and A. R. Ismaylov. "Industrial wastes of the cities of Baku and Sumgait and their effect on green plantings." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature, Effects and Symptoms of Air Pollutes on Vegetation; Resistance and Susceptibility of Different Plant Species in Various Habitats, In Relation to Plant Utilization for Shelter Belts and as Biological Indicators. M. Y. Nuttonson (ed.). Vol. 2, Silver Spring, Md. American Institute of Crop Ecology, 1969, p. 6-7. (Also: Akad. Nauk SSSR Ural. Filial. Komis. po Okhrane Prirody. Rastitel' nost'i promyshlennye zagryazneniya. Okhrana prirody na Urale, V (Sverdlovsk), p.37-38 (1966).

The industrial centers of the Apsheron Peninsula discharge a great amount of wastes, particularly carbon monoxide, sulfur dioxide, fluorine compounds, hydrocarbon vapors, chlorine, and hydrogen sulfide. In most cases, these compounds adversely affect green plants which function, at times, as protection against gas and smoke. When the air is polluted by irritant gases dark brown burns appear on the leaves. Partly withered and some yellowed leaves are also found. The toxic action of these pollutants also affects the root system. Trees which exhibit gas resistance include elm, maple, pistachio, oleaster, almond, honeysuckle, and others. The establishment and development of green trees are important as a means of combatting air pollution and for the sanitary well-being of the industrial areas. Several recommendations for establishing green plantings in industrial area are included.
Source: 1

#749
Anderson, P.J. "The effect of dust from cement mills on the setting of fruit." Plant World, 17(3):57-68 (1914).

Fruit growers in the vicinity of Hudson, New York, in the spring of 1910 complained that their crops were seriously damaged by dust from large cement mills which had recently been located there. They noticed particularly a decrease in the amount of fruit that was set on trees within the dust zone. Investigations were undertaken to determine the nature and extent of the alleged injury and, if possible, to find a remedy. Dust from the cement kiln stacks was found to settle on the vegetation within a radius of two

miles from the mills. This dust contained a large amount of alkaline, soluble calcium salts. When the dust falls on the fruit blossoms, some of it goes into solution in the stigmatic secretions and pollen falling on the stigma will not germinate. Thus the flowers will not be fertilized. Artificial germination tests show that pollen will not germinate even in very weak solution of the dust. When the blossoms are dusted as fast as they open, only a very small percentage sets fruit.
Source: 1

#1012
Anderson, W. C., and O.C. Taylor. "Ozone induced carbon dioxide evolution in tobacco callus cultures." Physiol. Plantarum., 28:419-423 (1973).

Callus derived from Bel-W3 and Bel-B tobacco plants when exposed to ozone turned brown as a consequence of sulface cell destruction. Ozone fumigations above a threshold concentration of 0.10 microliters/1 for 2 hr caused an increase in the rate of tissue carbon dioxide evolution. The maximum increase in CO_2 evolution was about 65% for both the ozone-sensitive Bel-W3 and resistant Bel-B callus. However, the ozone dosage required to attain maximum increase in CO_2 evolution was approximately two times greater for the resistant variety. Callus cultures that grew roots were more resistant to ozone. The addition of the antioxidant N,N prime diphenyl-p-phenylenediamine (DPPD) to the nutrient medium retarded ozone-induced CO_2 evolution.
Source: 1

#752
Anon. "Damage caused due to foundry smoke." Allg. Forst Jagdz., 67:220 (June 12, 1891).

A strong red discoloration of pine trees and damage to other trees were observed in the vicinity of a factory located by the Rhine River which process phosphorites. The Belgian phosphorites used by the factory in question contained 5.25% calcium fluoride; in the reaction with concentrated sulfuric acid, there was consequently a capacity to generate 2.7% hydrofluoric acid. Hydrofluoric acid vapors are exceedingly soluble in water and upon contact with moist objects they were completely trapped. Leaf damage occurred when sulfuric acid was experimentally poured over two grams of calcium fluoride and the vapors generated were fumigated over a plant. Further observations indicated that a very rapid condensation of the acid vapors occurs in the presence of a moist atmosphere. The presence of fluorine was determined in almost all lead samples from the area in the vicinity of the factory.
Source: 1

#751

Anon. "Fluorschaeden bei Rheinfelden und Moehlin." (Damage caused by fluorine near Rheinfelden and Moehlin). Text in German. Leben und Umwelt (Aarau), 12(3):69-71 (December 1955).

In 1952 the widespread dying of bees was for the first time attributed to the fluorine in flue gases of the aluminum plant in Rheinfelden-Baden. The bees contained from 5 to 112 mg fluorine in 100 g dry substance while the norm is 0 to 4 mg. In 1953 damage was noted for the first time in vegetation in the form of marbleizing and peripheral damage to leaves. Leaves curled up and assumed a spoon-like shape. More severe damage was manifested by necrosis proceeding from the leaf rib along the rims. Conifers exhibited similar symptoms and some complete defoliation occurred. Especially afflicted were cultures of clover, all cereal crops, and various grasses. The harvest was redueed by 50%. In 1955 cows were afflicted by a peculiar disease; they began to tremble, lost weight, and manifested pain in legs and joints. They often broke ribs and other bones. The fluorine content in cow bones was 6-10 times higher than the norm. These animals, suffering from fluorosis, either recovered spontaneously or died; administration of vitamins did not have any effect. Domestic animals not fed with green fodder or hay were unaffected, as were humans. The milk and meat of the diseased animals did not contain excessive levels of fluorine. Elevated levels of fluorine were detected in vegetation to a distance of 6 km from the factory.
Source: 1

#1857

Anon, "Effect of air pollution on vegetation." In: Air Pollution Manual, Part I, Evaluation, Detroit. American Industrial Hygiene Assoc., 5:49-61 (1960).

Local meteorology, industrial operations, type of fuel in general use, incinerator practice, motor fuel consumption, and other factors all contribute to the individual character and extent of the pollution produced and the resulting damage to vegetation. Gas exchange by the plant takes place largely by diffusion through the many breathing pores or stomata, thereby permitting the entry of gaseous phytotoxicants into the leaf. Light, temperature, humidity, soil moisture, fertility conditions, and stage of growth all play a part in controlling gas absorption by the plant. Plant injury due to sulfur dioxide, fluorides, oxidants, chlorine, hydrogen sulfide, ammonia, mercury vapor, and ethylene are considered. The use of plants in measuring and evaluating air contaminants is discussed, as well as the inspection of plants in making a field survey.
Source: 1

#753

Anon. "New technique aids study of smog effects on citrus plants." Chem. Eng. News, 39(8):42-43 (Feb 20, 1961).

A technique for removing oxidants from smog without affecting the concentration of fluorides was developed for use in a long-term study

of smog damage to citrus trees. The technique is based on the gas-phase reaction between oxidants and nitric oxide, which removes virtually all the ozone though not all the peroxyacyl nitrates. The pollutants are first mixed with filtered room air and fluoride, then with the reductant in a large polyethylene reaction chamber. If desired, hydrogen sulfide can be added to air leaving the chamber to promote further oxidant removal. Effluent from the chamber is divided between a fluoride recorder and an oxidant recorder. The possibility that hydrogen sulfide might protect plant leaves from oxidants is noted.
Source: 1

#316

Anon. "Taikiosen to shokubutsu higai-Chiba-ken Ichihara chiku no nashi no higai o chushin tosuite." (Air pollution and plant damage with special reference to the damages of pear trees in Ichihara District, Chiba Prefecture). Chiba Prefecture. Japan. 158 p. (March 1968).

The causes of plant damage between 1965 and 1966 in Ichihara City, Chiba Prefecture were investigated and countermeasures were examined. Damage was seen in pear orchards, street trees, and shrubs located near an oil-refinery, petroleum chemical factories, and a steam-power plant, which mainly use heavy oil. Damage to peaches was frequent at the time of flowering and expansive growth, when the resistance to sulfur dioxide was greatest. The time that the damage occurred agreed with the time when the concentration of SO2 was high. Therefore, damage was mainly due to SO2. Damage to pear trees sprayed with the coal Bordeaux mixture was also observed. However, damage by agricultural chemicals had never been seen, so the relationship between such phenomena was investigated. Deciduous broad-leaved trees are easily affected, and evergreen broad-leaved trees are relatively resistant. A correlation was observed between the damage and the direction of flying contaminated substances. The damage was heavy in the cases of a north wind, rainy weather, smog, stagnant air current, and successive fine weather. The relationship between damage and these elements was investigated. The occurrence of damage in 1965 and 1966, possible causes, countermeasures, and results were discussed.
Source: 1

#1914

Anon. "Waste problems of agriculture and forestry." Environ. Sci. Technol., 2(7):498-503 (July 1968).

The major contaminants of air, water, and land soil produced by agriculture and forestry are reviewed. A Department of Agriculture report "Wastes in Relation to Agriculture and Forestry" is the basis for this relatively brief discussion. With concentration of livestock and poultry in large enterprises, waste disposal becomes a significant problem. Wastes from orchards, grain fields, and rangelands are frequently burned thus contributing to air pollution. Processing agricultural and forestry products yields a variety of wastes.
Source: 1

#1288
Anon. "Where does it all go." Stanford Res. Inst. J., 23:4-8 (Dec. 1968).

The Environmental Research Department of Stanford Research Institute undertook a global study of the atmosphere. The world and its surrounding atmosphere were considered as a complete system. Estimates were made of the amount of sulfur compounds, nitrogen compounds, organic compounds, and inorganic carbon compounds discharged to the air by automobiles, home furnaces, or power plants. Calculations were made of the amount of the material in the atmosphere. By comparing the two figures it was possible to estimate how effectively nature removes pollutants from the atmosphere. Included in the atmospheric balance was the amount of material contributed by nature since there are natural sources for a wide variety of gaseous materials and particles which are classified as air pollutants when they are emitted by man's activities.
Source: 1

1083
Anon. "Air pollution and Ankara's meteorological aspect." Transl. for APTIC by Belov & Assoc., Denver, Colorado, 1970.
Meterol. Noleri Genel Mudurhigu Yainlari, p. 1-16 (1969)

With air pollution becoming an increasing problem, only a few studies concerning meteorological factors have been taken into consideration for its elimination. Wind speed and direction, humidity, rainfall, temperature, cloud cover and fog are considered in the dispersion and reduction of air pollution.
Source: 8

#756
Anon. "Jumoku ni taisuru taikosen no eikyo. Dai 3 po, Gairo juyo no io ganryo to sono bunbetsu." (Effect of air pollution on trees. 3. Analysis and fractionation of sulfur in the leaves of street trees). Kanagawa-Ken Taiki Osen Chosa Kenkyu Hokoku (Tech. Report Air Pollution Yokohama-Kawasaki Ind. Area), 11:100-113 (Feb 1969).

In order to determine the correlation between air pollution and withering of trees, sulfur compounds were fractionated from the surface of leaves or from themselves in 59 districts in Yokohama City and Kawasaki City, and their content was estimated. From the standpoint of regional groups, both sulfuric acid calculated as sulfur trioxide on the surface and in the leaves and the ratio of it to total sulfuric acid were significantly higher in the industrial areas; sulfuric acid in the leaves was somewhat higher in those areas. In industrial areas, the content of sulfuric acid was high in plane trees and sultan's parasol; in non-industrial areas, it was high in willow trees. The correlation coefficient between the content of sulfuric acid and the amount of sulfur compounds in the air was 0.771 for sulfuric acid in the leaves and 0.597 for total sulfuric acid. From analysis of sulfur compounds in water-soluble fraction (A) which was absorbed on the surface of leaves, water soluble fraction (B) which was extracted by heated water, acetate-soluble fraction and insoluble fraction of street trees , it was clarified that sulfuric acid was high in the water soluble fraction (A) and in the total sulfuric acid fraction of the trees which were planted in the industrial areas, although there was somewhat a difference among the groups of trees. Sulfuric acid in the water soluble fraction (B) showed no difference among regional groups. Sulfuric acid in the acetate-soluble fraction was low.
Source: 8

#337

Anon. "Taikiosen no eikyo. Taikiosen to jyuyo no ioo ganryo tono kanrensei." (Influence of air pollution. 3. The relationship of the sulfur content of trees to air pollution). Kanagawa-Ken Taiki Osen Chosa Kenkyu Hokoku (Tech. Rept. Air Pollution Yokohama-Kawasaki Ind. Area), 12:72-78 (Nov.1969).

The relationship of the sulfur content of trees to air pollution in Kanagawa Prefecture was reported. Needle-leaf trees like cedars and Japanese cypresses were sampled three times at 52 sites in Kanagawa Prefecture in September 1967; and at 12 sites in Yokohama and Kawasaki in January and April 1968. The measured sulfur content of cedars and Japanese cypresses were as follows: the minima were 0.10% in cedars and 0.12% in Japanese cypresses. Correlation between the sulfur content of cedars and Japanese cypresses and the correlation coefficient was 0.91 in cedars and 0.89 in Japanese cypresses. Broad-leaf trees like sweet oleanders and spindle trees were investigated once only at 13 sites in Yokohama and Kawasaki in January 1968. The maxima were 0.73% in sweet oleanders and 0.76% in spindle trees, and the minima were 0.30% in sweet oleanders and 0.26% in spindle trees. They showed higher values than those of either cedars or Japanese cypresses. Deciduous trees like gingkos and cherry trees were investigated on nine occasions at three sites in Yokohama and Kawasaki from April to October 1968. Sulfur content increased as leaves grew. Cherry trees were affected by oxides of sulfur less than gingkos.
Source: 1

#755

Anonymous. "The influence of air pollution, 3. 1. The influence of air pollution on trees. 2. The characteristics of insoluble substances adhered to the leaves of roadside trees." (Jumoku ni taisuru taikiosen no eikyo. Dai 2 ho. Gairoju no yomen no fuchaku shita fuyokaisei busshitsu no seijyo) Text in Japanese. Kanagawa-Ken Taiki Osen Chosa Kenkyu Hokoku (Tech. Rept. Air Pollution Yokohama-Kawasaki Ind. Area), 11:94-99 (February 1969).

Studies were performed on insoluble substances adhering to the leaves of roadside trees with respect to regional and seasonal distribution and alteration, relationship of falling soot and dust amounts, chemical constituents, x-ray diffration flexibility, and evaporative amounts of leaves at nine place of Yokohoma, Kawasaki, and Hiratsuka. In addition, the relationship of the insoluble substance to the concentration of air pollution was studied. The industrial areas had a difference of 4.2 to 6.5 times in g/sq. m of insoluble substance in comparison with non-industrial areas and the amounts increased from spring to mid-summer. The correlation coefficient between insoluble constituents in the falling soot and dust, total amounts of falling soot and dust, sulfur oxides, and insoluble substances adhering to the leaves was 0.602, 0.477 and 0.802; the contaminating influence by sulfur oxides was the highest. As the result of analysis by alkali dissolving method, silicon dioxide was the highest with a little magnesium oxide. There were many peaks in x-ray diffraction due to quartz and feldspar which contained mainly silicates. The peaks were more numerous in the falling soot and dust in the industrial area, and this fact presented their compound constituents. The evaporative amounts of leaves per unit increased in places where adherent amounts were more in the industrial area; there was no difference between other industrial places and non-industrial areas.
Source: 1

#1960
Anon. "Chlorine and air pollution: an annotated bibliography." Office of Air Programs, Research Triangle Park, N. C. Air Pollution Technical Information Center, Pub. AP-99, 113 p. (July 1971).

A bibliography is presented which contains 162 abstracts of documents and articles pertaining to chlorine and air pollution. Emission sources, atmospheric interaction, measurement methods, control methods, air quality measurements, standards and criteria, and basic science and technology are considered. Human health effects due to chlorine are also indicated, as well as effects on plants, livestock, and materials.
Source: 1

#1973
Anonymous. "LeVaudreuil: French experiment in urbanism without tears." Science, 173:39-41 (1971).

France is constructing the world's first industrial city, Le Vaudreuil, which is designed from the earliest stages to control air, water, and noise pollution. The new city will be neither a company town nor a suburbanite dormitory. Some of the features of LeVaudreuil include strict codes on the heights of chimneys for optimum dispersion of fumes, one-way streets with timed traffic lights to facilitate nonstop traffic flow, the use of garbage and solid waste to supply energy for the city's heat supply.
Source: 8

#416
Anonymous. "Blei aus Kraftfahrzeugabgasen in Gruenkohl." (Lead from the exhaust gases of automobiles in green cabbage). Text in German. Deut Med. Wochenschr., 97(21):856 (May 1972).

Examinations of a large number of green cabbage samples taken various distances from highways and roads revealed that the lead concentration was higher in plants that grew closer to the road. The fraction of the total lead content which could be washed off was small and ranged on the average around 10%. Boiled samples generally contained more lead than unboiled ones with the use of an enamelled pot for boiling. No increase of the lead content was observed when the samples were boiled in glass dishes.
Source: 1

#754
Anonymous. "Einfluss des Leuchtgases auf die Baumvegetation." (The effect of coal gas on the vegetation of trees). Translated from German, Belov and Associates, Denver, Colo., 3 p., May 17, 1970. Jahresber, Agrikultur, 13:236-237 (1870-1872). (Also: Nachr. Botan. Z., 89: 50-51 (1871) and Der Naturforscher (1872).

Experiments were conducted on two linden trees and one maple to determine the effects of coal gas on their vegetation. Each linden tree had two pipes installed at a depth of 84 cm and each was supplied with a burner at a distance of 110 cm from the trunk. The maple was supplied with four burners, 118 cm from the trunk. Three gas meters were used to determine the daily amount of

coal gas to which the trees were exposed. The damaging effect of the coal gas became apparent with a speciment of evonyums, which was next to the maple. Within a short time, the leaves of the maple and of an elm tree at a distance of 2.8 m began to wilt. Within three months, the linden trees were completely defoliated. The roots showed a blue coloration which progressed from the center to the periphery. This indicated that the coal gas had penetrated along the growing root ends and not through the bark of the older root parts. Within several months, the maple, elm, and evonyums bushes were completely destroyed; their wood was dead, their cambium withered, and the maple showed a prolific fungi formation. Although the linden trees grew leaves at the normal time, they had a pale coloration and were smaller than normal. Also, the cambium withered and the side of the trunk nearest the gas meters showed the same fungi formation as the maple. These tests show the effects of coal gas on tree vegetation and the varying sensitivities of different species to coal gas.
Source: 1

#1014
Anon. "Taiki osen ni yoru norin sakumotsu higai no sokutei hoho ni kansuru kenkyu." (Studies on the measurement methods of damage to agricultural produce by air pollution). Nogyo Gijutsu Kenkyusho Hokoku A, 1972:56-60 (Sept 1972).

Studies were made on the effects of air pollution on plants and agricultural produce, starting in 1968. In 1971, the research programs included the relationship between the absorption of toxic gases in plant leaves and the wind velocity, sunshine, and the conditions of the leaf surfaces; the distribution of sulfur in the plant which has absorbed sulfur dioxide; the morphological analysis by equipment of the damaged plants and radiochemicals studies, the effects of sulfur dioxide on the growth of vegetables, fruit, and plants; the sulfur content in the leaves; the explanation of the damage mechanism and metobolic changes of plants exposed to SO_2; the analysis of plant damages by hydrogen fluoride and ozone and the distribution of these pollutants in the plants. The seasonal fluctuation of susceptibility of plants to pollutants varied by various species. The susceptibility of certain kinds of adhesive tissues proved useful in measuring the degree of air pollution. The distribution pattern of the moss proliferation was used as an indicator of SO_2 pollution, and a map was formulated. The plants do not respond to automotive exhaust gases as clearly as they do to SO_2.
Source: 1

#1015
Anon. "Saving the green." Agri. Res., 21(4):3-5 (October 1972).

Sixty-five varieties of petunias were rated for tolerance and sensitivity to ozone in fumigation chamber experiments. The most tolerant plants were Capri, Fire Gleam, Pink Joy, Popeye, and Purple Plum; the most sensitive were Fiesta, Harmony, Pink Paradise, Snow Magic, and White Joy. The 55 remaining plants fell into four intermediate categories. The ability of different growth-retarding chemicals to protect petunia plants against ozone damage was also evaluated. Succinic acid, 2,2-dimethyl hydrazide (SADH) was outstanding in protecting the plants. Although twice as much SADH was required for best plant protection than is required to produce compact plants in nurseries, plants sprayed for greatest ozone protection were no shorter than those sprayed for compact growth.
Source: 1

#1016
Anonymous. "Auswirkungen auf die Pflanzen." (Impacts on plants). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, 6:324 (December 1973).

The impact of air pollution on plants in general, and on trees in particular, is outlined. Several plants are highly sensitive to air pollutants, especially to fluorine, sulfur dioxide, and ethylene. Direct injury of the epidermis, penetration of the toxic substances through the stomata of the leaves and needles, and resorption from contaminated rainwater and contaminated soil are possible. While relatively high concentrations of air pollutants cause visible, serious damage to plants, low concentrations can reduce the vitality of the plants, and can increase their sensitivity to cold, drought, heat, and pests. Mixtures of SO_2, and ozone, as well as of SO_2 and nitrous gases are especially dangerous due to the potentiating effect of the individual components.
Source: 1

#935
Anonymous. "Chlor und Salzaeure." (Chlorine and hydrochloric acid). In: Die Beschaedigung der Vegetation durch Rauch. Handbuk zur Erkeunung and Beurteilung von Rauchschaeden, Chapt. 2, p. 230-256. (Damage to vegetation by fumes. Handbook for the identification and assessment of fume damage). Translated from German. Leo Kanner Associates, Redwood City, Calif., 38 p. March 1973.

The phytotoxic effects of chlorine and hydrochloric acid are reviewed. Topics covered include: industrial sources of hydrochloric acid and chlorine compounds, effects on the soil, effects on the roots of plants, effects on above-ground plant organs, plant morphological changes, and induced changes in plant physiology. Common sources of these pollutants include: ore smelting and refining operations, fertilizer plants, and chemical processing operations. Damage to vegetation results from the action of these pollutants on above ground organs rather than from indirect action through the soil. The effect chlorine is sudden and more severe and rapid than that of hydrochloric acid. Hydrochloric acid damage starts at the edge of the leaf, with the leaf tips eventually turning brownish. Chlorine causes bleaching rather than browning, with the leaf surface turning from green to white or yellow. The main plant function affected by hydrochloric acid is that of assimilation. A number of examples of hydrochloric acid and chlorine induced plant damage are given from field observations.
Source: 1

#1326
Anon. "Erzeugung von Aerosolen durch die Vegetation." (The production of aerosols by vegetation). Naturw. Rundschau, 26(1):31-32 (1973).

The blue haze which is frequently noticed over trees and mountain ridges might be due to the wax found on the surface of the leaves. These waxes consist of alkanes, alcohols, acids (usually in the form of esters), polymerized aldehydes and ketones. At the application of an electric voltage the wax is split off in form of a brush discharge. The local voltage gradient in a tree may reach several 1000 volts/m if an electrified cloud passes over it. This observation points to the fact that wax particles of a size suitable for producing the blue haze are produced by natural forces. Factors such as gaseous or particulate air pollutants may influence the properties of the wax and thus reduce or increase the rate of wax discharge. It could be possible that through shedding the wax layer the needle tips set so exposed that they are lost through drying out.
Source: 1

#954
Anon. "Air pollution on the farm." (No publisher and date)

Field crops are raised under plastic tents with controlled amounts of common air pollutants. The effect on soil, plant growth, and crop yields is measured. Preliminary results show (1) air pollution limits severely the conversion of nitrogen in air to fixed nitrogen, (2) certain heavy metals also inhibit N-conversion, (3) cadmium and selinium particles slow down the rate of decay of soil litter. Acid rain tests are also underway. Radioactive trace elements are being used to follow movements of chemical pesticides so information can be found concerning how they are stored in plants, where they are stored, and how they change and decay.
Source: 8

#45
Antipov, V. G. "The effect of industrial smokes and gases upon coniferous forests growing under conditions of increased humidity in the Moscow Region (Podmoskov'E)." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Vol. III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union. M. Y. Nuttonson (ed.) Silver Spring. American Institute of Crop Ecology, p. 39-44, 1970. Translated from Russian. (Also Byull, Gl. Bot. Sada 46: 41-46 (1962).

An investigation of the relationship between industrial pollution and damage to coniferous trees is presented. A definite correlation between the destruction of pines and their distance from industrial enterprises is noted. The accumulation of sulfates, by the assimilating mechanism, is one of the verified symptoms of damage to plants from sulfur dioxide. The effect of humidity upon the concentration of atmospheric pollutants is discussed. The presence of fog increases the concentrations of pollutants. Increased humidity is not only conducive to acidic fogs, but also prevents the closing of the stoma, a condition which allows easier penetration of pollutants. The toxicity of sulfur gases is increased if carbon monoxide, nitric oxides, aldehydes, and ozonides are present. Ammonia, hydrogen sulfide, and hydrogen fluoride are other serious contaminants.
Source: 1

#750
Antipov, V.G. "The influence of smoke and gas on the flowering and fruiting of some trees and shrubs." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature, Vol III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union. M. Y. Nuttonson (ed.), Silver Spring, Md., American Inst. of Crop Ecology, p. 3-8 (1970). Also: Sb.Bot Rab., Beloruss, Otd. Vses. Bot Obshchest, 2:167-172 (1960).

Twenty-five speices of trees and shrubs were examined for the effect of chemical plant smoke and gas emissions on fruiting and flowering. Flowering was satisfactory for the majority of species. Although significant quantitative decreases in the number of flowers occurred in the common birch, pendunculate oak, snowy mespilus, and cluster bird cherry, complete absence of flowering was observed only with the balsam poplar. Gas and smoke exhibited a stronger influence on fruiting, with fruiting completely absent on the birch, Russian elm, pedunculate oak, round-leaved serviceberry, Japanese rose, Urals false spirea, black currant, balsam poplar, and cluster bird cherry. In addition, there was a significant decrease in fruit in Tartar dogwood, European barberry common hawthorne, red berry elder, ledge cotoneaster, Norway maple, speckled alder, mountain ash, and sweet mock orange.
Source: 1

#1018
Antipov, V. G., and I. I. Chekalinskaya. "Variation in the oxidizability of the cell content as one of the indicators of gas resistance plants." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature, Vol. III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union, M. Y. Nuttonson (ed), Silver Spring, Md. American Institute of Crop Ecology. Translated from Russian (Also: Okhrana prirody na Urale, Vol. 5:29-35, 1966)) p. 100-108 (1970).

Variations of oxidizability of plant cells with plant growth and development were studied in gas-resistant eastern poplar and Colorado spruce, low-resistant linden, red ash, birch, Norway and English white pine, and English oak. Preliminary results indicate that changes in the oxidizability of cell content, particularly water-insoluble substances, are connected with the developmental phase of leaves. Life activity of plants is related to increased ozidizability of the cell content, a lowering in life activity of the plant leading to a decrease in its oxidizability. In conifers, oxidizability is related to air temperature. Acceptance of the oxidzability of the cell content and its water-insoluble substances as an indicator of degree of gas resistance should take into considerable variations. Selection of woody plants should take into account the duration of the gas resistance period of the particular species in the course of its growth. The duration of distinct phenophases of the plant could serve as an indicator of such periods.
Source: 1

#1019
Arai, M. "Tokyo-to ni okeru roju meiboku no katsuryoku hyoka ni tsuite." (Evaluation of old and famous trees in the metropolitan Tokyo area). In: Study on Animals and Plants as Human Environmental Indices under Urban Environment. Japan Environmental Agency. 15 p. (March 1973).

The old and rare trees that are officially designated as natural treasures by the government, prefecture, cities, or townships in the greater Tokyo area were studied for the evaluation of tree conditions in the light of air pollution. The measurements of the trunks were taken at 1.2 m above the ground, the heights were estimated; and the general conditions, shapes, branch lengths, damages on the tips of small branches, damages on the trunks, density, the shape of the leaves, the size of the leaves, the color of the leaves, and necrosis were observed. An evaluation index was given to each item and a classification of A to C was given to each tree. The tree species with the most number of specimens were gingko, zelkova, cedar, black pine, cherry, red oak, and linden. Gingko, kayatabunoki, and linden, which are believed to be resistant to air pollution, remain in the central 23 districts of Metropolitan Tokyo, and geographical differences cannot be recognized clearly in their conditions. But no old red pine, fir, hemlock, cedar, or cryptomeria remain standing in the metropolitan districts. In outer Tokyo where environmental conditions are better, these tree specimens remain, but some show signs of damage. The zelkova trees, the most representative tree of the Kanto Plain, remains in Metropolitan Tokyo to some entent, but shows much damage in general, and if the pollution condition continues to worsen, it will not remain long. Other old trees may also gradually disappear.
Source: 1

#1021
Arikadó, H., T. Taniyama, and K. Sawanaka. "Shihyo seibutsu no kanjusei oyobi teikosei kiko no kaimei." (On the susceptibility of index organisms and the mechanism of their resistance to air pollutants). Mie Univ. (Japan), Research Inst. of Crops, 17 p. (March 1973).

Investigations of actual plant damage due to air pollution in Yokkaichi pointed out plants appropriate for study as air pollution indicators. The effect of air pollution on the growth and yield of rice was studied. Hosta, gladioli, peonies, iris, ginkgo, metasequoia, and osmanthus are suitable plant indicators. Growth of rice plants was retarded in polluted areas: leaves were affected after the ears appeared; the number of stems was smaller; leaves were narrower; and the dry weights of the stems, leaves, and roots were considerably less. The harvest of the rice was reduced 35%, with the most significant reduction appearing in the number of ears per plant. There was an inverse exponential functional reduction of total dry weight and total harvest, and the average concentration of sulfur oxides in the air.
Source: 1

#1020
Arikado, H., T. Taniyama, T. Watanabe, and S. Sano. "Norin suisan seitaikei ni okeru osen busshitsu no junkan to shihyo seibutsu ni kansuru sogo kenkyu. II. Norin suisan kankyo ni okeru shihyo seibutsu no taisei genkai to sono riyo." (General studies on the circulation of pollutants in ecological systems of agriculture, forestry, and fisheries. The index organisms (Part II): The limit of tolerance of index organisms in the environment of agriculture, forestry and fisheries, and their utilization). Text in Japanese. Mic Univ. (Jap) Res. Inst. of Crops, 17 p., March 1974.

The selection of plant indicators for air pollution in agricultural areas of Yokkaichi is discussed. The effects of various air pollutants on the photosynthesis of rice and corn plants were studied experimentally, and the results of the actual field study of plant damages in Yokkaichi are given. Plant damages occurred in decreasing order to gladioli, Hosta, buckwheat, sesame, and morning glories, and there was a significant correlation with air quality measurements for the first three plants, showing their applicability as plant indicators. Photosynthesis in rice was more susceptible to air pollution than in corn, and it showed a faster rate of damage with greater severity to ozone, sulfur dioxide, chlorine, and nitrogen dioxide. Cumulative experiments with O_3, NO_2, and carbon monoxide were carried out in concentrations of 0.5-10.0 ppm. The rice harvest was reduced 21% as compared to 35% in 1972, probably because of the reduction in the aerial concentrations of SO_2. Specific plant damages include nonseasonal reddening of the leaves.
Source: 1

#1006
Arndt, U. "Konzentrationsaenderungen bei freien Adminosaeuren in Pflanzen unter dem Einfluss von Fluorwasserstoff und Schwefeldioxid." (Changes of concentration of free amino acids in plants under the influence of hydrogen fluoride and sulfur dioxide). Text in German. Staub, Reinhaultung Luft, 30(6):256-259 (June 1970).

After treating different types of plants for 14 days with air contain 6 micrograms of hydrogen fluoride/cu m or with air containing 017 mg of sulfur dioxide/cu m, their contents of free amino acids were determined by two-dimensional chromatography and were compared with those of the control plants. The individual amino acids were identified with the aid of calibration curves prepared using commercially available amino acids. Analyses of damaged plants showed, in general, increases of concentration of the individual acids. The same results were obtained after treating grass with HF in which no external symptoms of damage were evident. Plants treated with SO_2 and appearing undamaged, exhibited varying changes in concentrations of the individual amino acids, but there was also a trend towards higher total amino acid concentrations in this case. This suggests the possibility of utilizing the metabolic reactions investigated above as indicators of emission effects. To obtain a higher detection sensitivity of metabolic reactions, which are desirable as early indicators of emission effects, further studies are planned in which no extracts from the entire plant body but only those from certain cell complexes will be analyzed. This kind of sampling separates the various metabolic circuits from each other, which may react differently to the same emissions and, hence lead one to expect more unequivocal results.
Source: 1

#417
Arndt, U. "Konzentrationsanderungen bei Blattfarbstoffen unter dem Einfluss von Luftverunreinigungen. Ein Diskussionbeitrag zur Pigmentanalyse." (Air pollution induced leaf pigment concentration changes. A contribution to the discussion of pigment analysis). Text in German. Environ, Pollut., 2(1): 37-48 (July 1971).

The value of pigment chang is discussed as an early indication of the effects of air pollution on plants. Wheat, oat, and rye plants were exposed to the effects of hydrofluoric acid, of sulfur dioxide, and of hydrochloric acid for varying periods of time and until necrosis set in; then chlorophyll A, chlorophyll B, and beta-carotene were extracted from exposed and control plants and analyzed chromatographically and spectrophotometrically. Control plants exhibited a dependence of the pigment concentration on plant strain, age, and on, ecological conditions prevailing prior to and during the experiment. While the content of both chlorophyll A and B was not affected by exposure to the pollutants, the content of beta-carotene decreased by 20 to 35% in plants exposed to SO_2 and HCL. In plants exposed to HF, the drop was less significant. Results of this study do not warrant the use of changes in pigment content as an early indicator of the effect of pollution on plants but the question should be pursued in the case of the yellow chloroplast pigments.
Source: 1

#1022
Arndt, U. "The Kautsky-effect: a method for the investigation of the actions of air pollutants in chloroplasts." Environ. Pollut., 6(3):181-194 (April 1974).

The characteristic variable fluorescence of green plants (Kautsky-effect) was used to investigate the effects of air pollutants on metabolic reactions in chloroplasts. This technique in conjunction with oxygen measurements and pigment analysis gave an indication of effects-mechanisms for particular heavy metals such as copper, manganese, and zinc, as well as for sulfur dioxide. An example of the routine use of the Kautsky-effect in the testing of the toxicity of settled dusts is described.
Source: 1

#1151
Arnold, P.W. "Losses of nitrous oxide from soil." J. Soil Sci., 5:116-128 (1954).

Data obtained from infra-red spectra of soil airs collected both in laboratory experiments and in the field indicate that nitrous-oxide evolution is a factor of considerable significance to the nitrogen economy of soils. Soils which are approaching saturation with moisture rapidly release large amounts of their available nitrogen as nitrous oxide; at lower moisture contents, very slow evolution of the gas can take place. The soils of the earth are shown to be a very possible source of supply of atmospheric nitrous oxide.
Source: 5

#4
Ashby, W.C., and H. C. Fritts. "Tree growth, air pollution, and climate near LaPorte, Ind." Bull. Am. Meteorol. Soc., 53(3):246-251 (March 1972).

A multivariate technique was used to assess tree-ring growth and climatic relationships of white oak in northern Illinois-Indiana with possible correlations to air pollution. Basic data include the time series of annual ring widths and measurements of temperature and total precipitation for Joliet, Chicago, Valparaiso, LaPorte, and South Bend on monthly bases. Climate accounted for 59% of the variance in ring-width chronology and prior growth accounted for 2%. The analysis neither proved nor disproved the precipitation anomaly at LaPorte, a phenomenon of summer convective storms, but suggested that the growth reduction may be a direct result of toxic effects from severe air pollution correlated with high levels of smoke-haze in Chicago. The study of tree rings, therefore, may serve as a record of past air pollution or may be suitable for documentation of anomalies in climate.
Source: 1

#5
Ashton, W. M. "Nickel pollution." Nature (London), 237(5349):46-47 (May 5, 1972).

Contamination of herbage and soil was investigated on a farm located near a nickel works and subject to emissions carried by prevailing winds. Qualitative examination determined the presence of considerable amounts of nickel with smaller amounts of copper in both herbage (oats, wheat, and grasses) and soil. Pasture herbage had a burned appearance; trees were withered and appeared to be dying. Soil samples established positive reactions for arsenic. Surface contamination opposed to plant content of the pollutants was examined. Washing removed most of the nickel from the leaf surface; washed peeled potatoes had only minute traces of nickel and copper.
Source: 1

#512
Atomic Energy Commission. "Nuclear power and the environment." U.S. Atomic Energy Commission, Division of Technical Information, Oak Ridge, Tenn. 30 p. (1969).

This report concentrates on adiscussion of the radiological and thermal aspects of the environmental effects of nuclear power plants; on procedures followed by the A.E.C. to minimize the impact of nuclear plants on man and his environment; and on the research conducted by the A.E.C. and others to further expand our knowledge.
Source: 2

#1971

Auerbach, S.I. "Progress report in postattack ecology." Interim Progress Report. Office of Civil Defense, Washington, D.C. (No date).

This report summarizes progress in research on postattack ecology being carried out by Oak Ridge National Laboratory for the Office of Civil Defense in cooperation with the Atomic Energy Commission. Postattack ecology is concerned with the interim and long-term environmental consequences of a nuclear attack. The program at ORNL is particularly concerned with the effects of fallout and residual radiation on insects, rodents and native and crop plants. Artificial fallout particles containing beta ray or beta-gamma ray emitting isotopes are being used extensively in the ORNL program. These particles are produced at a special facility at Camp Parks, California which is operated by Stanford Research Institute for the Office of Civil Defense. At ORNL emphasis is being placed on the use of ^{90}Sr tagged particles for the study of beta radiation effects on plants and animals under laboratory-controlled or field-simulated conditions. Cesium-137 tagged particles are being utilized in a field facility in which 4 plots each 1000 ft^2 are being contaminated with approximately 2.2 Ci of ^{137}Cs on silica sand particles (88-177 μ) which in turn will be spread over the plots at a load of 25 grams per square foot. In this report, research progress in four projects is reported: (1) The effects of external beta radiation on higher plants; (2) Uptake and excretion of ^{137}Cs from fallout simulant by rodents (cotton rats); (3) Effects of beta and gamma radiation on Sinella curviseta (insects); and (4) Honey bee irradiation studies.
Source: 8

#1023

Auersch, O. "Wissenschaftliche Ergebnisse aus der Feldversuchsstation fuer Immissions-kunde im Kombinat VEB Chemische Werke Buna, Schkopau." (Scientific results from the field experiment station testing the effects of immission in the combine VEB chemical plants Buna, Schkopau). Text in German. In: Technik und Umweltschutz Luft - Wasser - Boden - Laerm, Luftverunreinigung bestimmter Gebiete und technologische Verfahren zur Emissionsverminderung. Leipzig, VEB Deutscher Verlag fuer Grundstoffindustrie, 5:79-91 (1974).

By analyzing plant damage it is possible to determine the territorial expansion of phytotoxic emissions. In contrast to forests, short-lived field cultures or agriculture suffer, as a rule, only from acute damages. The effects on later yield have to be worked out for each case in order to decide on compensations for injuries caused. These injuries are always caused by a definite emitter within each local immission site.
Source: 1

#514
Aylor, D.B. "Deposition of particles of ragweed pollen in a plant canopy." J. Appl. Meteorol., 14(1):52-57 (February 1975).

Deposition of ragweed pollen released from a point above a corn crop was directly observed on foliage, and the number of particles deposited was related to the concentration of pollen in the air, the wind within the crop, and the foliage characteristics. At winds of 1-2 m s^{-1} deposition on the foliage both at the top and at the middle of the plants was primarily by sedimentation; while at winds of 3-4 m s^{-1}, deposition was enhanced at the top about threefold. Since 20 μm particles impact inefficiently on corn plants for usual wind speeds within the crop, they should penetrate far through the canopy before settling out by gravity.
Source: 2

#1962
Babich, H. and G. Stotzky. "Ecologic ramifications of air pollution." Society of Automotive Engineers, Inc., New York, Environmental Protection Agency, and Dept. of Transportation, Soc. Automotive Engrs. Int. Conf. Transp. Environ., Proc., Washington, D. C., Part I, Paper 720630, p. 198-214 (May 31-June 2, 1972).

Pollutants are emitted into the atmosphere by both industrial and natural processes. Natural processes also remove these pollutants, but, when total emissions exceed the capacity of natural sinks, the quality of the air decreases. Air pollution can damage plants, animals, and microorganisms. It can cause subtle damage to the biosphere, as manifested by growth retardation, acceleration of the aging process, alterations in reproductive potential and genetic constitution, and alterations in host-parasite relations. Pollution may also serve some beneficial roles, such as satisfying some nutrient requirements of plants. Field studies, however, indicate that the environment, in general, is adversely affected by atmospheric pollution. Unfortunately, only speculations on ecologic ramifications of air pollution are possible with the present level of knowledge. Pollutant symptomatology, factors affecting phytotoxicity (such as climate, soil, growth state, and physiological state), invisible injury on plants, synergism between pollutants, effects on reproduction and genetics, adaptation to air pollution, effects on host-parasites, effects on economics, and effects on natural ecosystems are also discussed.
Source: 1

#370
Babich, H., and G. Stotzky. "Air pollution and microbial ecology." Critical Rev.Environ. Control, 4(3):353-421 (1974).

The relationship between air pollution and microorganisms in the environment is considered in terms of microbes acting as sources of gaseous pollutants, serving as sinks and reaction sites of pollutants, and being themselves pollutants. Microbes release a variety of pollutants including the following: nitrogenoxides, hydrogen sulfide, ammonia, carbon monoxide, sulfur-containing gases, methane, ethylene, aldehydes, alcohols, and terpenes.

The gases and volatiles once in the atmosphere are primary sources for a number of particulate aerosols including nitrates, ammonium ions, sulfates, and nitrogen dioxide anions. Microorganisms also serve as scavengers or sinks for numerous gaseous and particulate emissions. Some microorganisms are themselves pollutants as a result of their role in aerial transmission of diseases and allergens. The predominant airborne microbes are fungal spores in contrast to the bacterial and viral aerosols. Additional research is needed to clarify the effects of air pollutants on microorganisms.
Source: 7

#20
Bach W. "Planning and air pollution control." McGraw-Hill. Atmospheric Pollution, 7 pp. (1972).

Author cites others on air filtering capacity of trees and states preservation of green areas in cities is one major planning chore by which city planners and landscape architects can influence air hygienic conditions of an urbanized area.
Source: 8

#1024
Baddeley, M.S., and B. W. Ferry. "Summary: Scope and Direction of Future Work." In: Air Pollution and Lichens. B. W. Ferry, M. S. Baddeley, and D. L. Hawksworth (eds.), Toronto, Toronto Univ. Press, Chapt. 17, p. 368-377, 1973.

Current and suggested research on the relationship between air pollution and lichens are discussed. There is limited knowledge on the effects of ozone, nitrogen oxides, organic effluents, and agricultural chemicals on lichens or the additive or synergistic effects of pollutants. The use of lichens as pollution indicators might be applied in urban planning and the siting and distribution of industrial sites through mapping techniques. Difficulties encountered in the application of mapping to identification and standardization of sites with respect to other environmental factors tend to limit its application. The development of transplant techniques offers potential for the simulation of field conditions in a laboratory. Further work is needed on the mechanisms of accumulation of pollutants in the lichen thallus, and the intracellular sites at which these substances are deposited.
Source: 1

#1025

Baddeley, M. S., B. W. Ferry, and E. J. Finegan. "Sulphur Dioxide and Respiration in Lichens." In: Air Pollution and Lichens. B. W. Ferry, M. S. Baddeley, and D. L. Hawkswoth (eds.), Toronto, Toronto Univ. Press, Chapt. 14, p. 299-313 (1973).

Methods of studying the effects of sulfur dioxide on lichen physiology, particularly respiration, in the laboratory are discussed. Emphasis is placed on the problems involved in relating conditions in laboratory experiments to field situations and on the need to maintain strict control of conditions in laboratory experiments. Sulfur dioxide concentrations were tested in the 1-112 ppm range in solution. With some lichens, effects of respiration were observed with concentrations as low as 3.5 ppm applied for 15 min. while in other instances there was still some appreciable respiration at 112 ppm after 18 hr exposure. Factors influencing sensitivity in laboratory and field situations include: the physiological state of lichen material at the time of exposure to SO2, the effect of lichen substrates and thalli on SO2, particularly with regard to oxidation to sulfate; influence of thallus morphology and wettability on SO2 uptake; and the possible importance of capacity to recover from sublethal doses of SO2 in the field.
Source: 1

#25

Baker, J., D. Hocking, and M. Nyborg. "Effect of atmopsheric sulfur dioxide on the pH of rain intercepted by forest trees." Environment Canada, Edmonton (Alberta), Canadian Forestry Service and Northern Forest Research Centre, and Alberta Environment, Research Secretariat, Proc. Workshop Sulphur Gas Res. Alberta, Edmonton, Alberta, p. 98-102 (1973).

Eight collection sites were established up to 8 mi from a gas processing plant which emits up to 84 long tons of sulfur dioxide per day in a lodgepole pine-dominated forest. Three control sites were established 10-12 mi upwind from the plant. Rainfall was collected in clearings and in immediately adjacent stands of lodgepole pine. Analyses were performed on samples for pH and sulfate levels. The average pH value of rain was 0.6 pH units lower than that of the control sites. The pH values of both throughfall and stemflow were 1.8 units lower at the sites near the plant than at the control sites on the average. These results were obtained from Aug. 17 to Aug. 30. Intercepted rain was consistently higher than open rain in total sulfate content. The increased acidity of intercepted rain could have been done due to the adsorption of emitted SO_2 on the surface of needles and/or tree bark. Data on sulfate content were consistent with this hypothesis, but not yet supportive of it due to the deficiency in analytical method. The SO_2 emissions did acidify intercepted rain more than open rainfall. Stemflow was the most acid. The impact of the very acid stemflow on soil acidity would likely be limited to an extremely small area at the base of the tree. This increased acidity of intercepted rain may help to explain the fate of some SO_2. Emissions in forests may be adsorbed and later washed off in intercepted rain.
Source: 1

#1026

Barber, J., W. Beauford, and Y. J. Shieh. "Some aspects of mercury uptake by plant, algal and bacterial systems in relation to its biotransformation and volatilization." In: Mercury, Mercurials and Mercaptans. Morton W. Miller and Thomas W. Clarkson (eds). Charles C. Thomas, Springfield. Chapt. 19, p. 325-345 (June 1971).

Studies of mercury uptake by plant, algal, and bacterial systems showed absorption of Mg into the roots of Mentha spicata from solutions of mercuric chloride or acetate and small quantities translocated to the leaves but with no evidence that the metal entered the transpiration effluent; on the other hand, Pseudomonas fluorescens and another bacterium isolated from Mg-rich soil were shown to facilitate the volatilization of Mg. Anomalous atmospheric Mg levels detected over heavily vegetated areas associated with Mg-rich soils are thus postulated to be partly due to bacterial action on mercury-containing organic debris. Addition of mercuric chloride at concentrations of .0001 M and above to suspensions of Chlorella pyrenoidosa resulted in a breakdown in the permeability of the cell membrane as indicated by a rapid net efflux of internal potassium. A stimulation of the potassium-potassium exchange across the cell surface without any change in the cytoplasmic level of this cation occurred between .00001 and 5 times .00001 M HgCl2. Maximum stimulation occurred at about 30 times .00001 M. Enhancement of the rate of K turnover was associated with a fast component of the Mg uptake which could be removed by washing with cysteine. The Mg stimulated K-K exchange was inhibited by low temperature and by the uncoupler carbonlyl cyanide m-chlorophenyl-hydrazone at 5 times .00001 M. Concentrations below 6 times 10 to the minus 6 M HgCl2 had no effect on the K transport system.
Source: 1

#757

Barkman, J.J. "The influence of air pollution on bryophytes and lichens." Council of Europe, Committee of Experts on Air Pollution, Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 197-209, April 22-27 (1968).

Since only few data are known on damage caused by air pollution to algae and fungi, its effect on bryophytes and lichens, especially epiphytes, is discussed. The decline of the epiphytic flora and vegetation in the Netherlands during the last hundred years and the formation of epiphytic deserts in and around towns in Europe and America are discussed. Both dryness of town climate and air pollution are responsible, with the latter being the main factor. The physiologic basis of the high sensitivity (compared with flowering plants) of bryophytes and lichens to air pollution, the influence of rain on pollution effects, and the increased acidity of plants and substratum caused by sulfur dioxide are considered. Bryophytes and lichens show a wide range of specific sensitivity; therefore, epiphytic vegetation maps can give an approximate idea of the gradation of pollution levels and their pattern in a certain area. This is elucidated by the example of Limburg, Belgium.
Source: 1

#33
Barnes, R. "Effects of chronic exposure to ozone on photosynthesis and respiration of pines." Environ. Pollut., 3(2):133-138 (April 1972)

Studies were conducted in a laboratory on seedlings of four species of pine which were exposed to either 5 or 15 pphm of ozone for periods from 5-18 weeks. Changes in rates of photosynthesis, depending on species and age of foliage. Little effect was noted with younger seedlings of which pines, which bore only primary needles, while photosynthesis was depressed slightly in secondary needles of older seedlings. With the yellow pines (slash, pond, and loblolly) a possible stimulation occurred in older secondary needles, but photosynthesis was usually depressed in younger secondary needles. The higher ozone concentration (15 pphm) had a more consistent depressing effect on all species. The most clearcut effect of ozone was on respiration. Although 5 pphm was not always effective, a concentration of 15 pphm stimulated respiration consistently, in one case as much as 90%.
Source: 1

#21
Barnes, R. L. "Effects of chronic exposure to ozone on soluble sugar and ascorbic acid contents of pine seedlings." Can. J. Botany, 50(1):215-219 (January 1972).

Small seedlings of five pine species (Pinus strobus, echinata, elliotti, serotina, and taeda) were exposed to low levels of ozone for periods from 5 to 22 weeks. Exposure to 5 pphm O_3 resulted in significant increases in total soluble carbohydrates, reducing sugars, and ascorbic acid. In seedlings exposed to 15 pphm O_3, soluble sugars were higher than in the controls but ascorbic acid levels were not. Reasons for the increases in soluble sugars and higher ascorbate levels are cited.
Source: 1

#311
Barrett, T. W., and H. M. Benedict. "Sulfur Dioxide." In: Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas. Jay S. Jacobson and A. Clyde Hill (eds.), Pittsburgh, Pa. Air Pollution Control Assoc., p. C1-C-17 (1970).

The effects of sulfur dioxide on various plant species are discussed. Different species vary in their sensitivity to SO_2 when exposed to this gas under conditions favorable for its absorption by the plant. Plants which are sensitive to SO_2 are shown in tabular form. When SO_2 enters the mesophyll tissue of the leaves, it reacts with water to produce the sulfite ion which is oxidized to sulfate ion. The sulfite and sulfate ions are toxic to plant cells when present in large amounts. Because of its reducing potential, the sulfite ion is estimated to be 30 times more toxic than the sulfate ion. The accumulation of sulfite produces two types of markings depending on the accumulation rate: chronic and acute. Chronic injury is characterized by a general chlorotic appearance of the leaf. Acute injury resulting from the absorption of lethal quantities of SO_2 appears as marginal or intercoastal areas of dead or necrotic tissues. It is characteristic to find both chronic and acute markings on many species after an SO_2 exposure. Plants are more susceptible to SO_2 when the sugar content of the leaves is low, such as in early morning. The younger fully-expanded leaves are more sensitive to SO_2 followed by the older leaves, while the enlarging leaves are the last to show injury.
Source: 1

#1216
Baumgartner, A. "Sauerstoffumsaetze von Baeumen und Waeldern." (Oxygen budget of trees and forests). Allgemeine Forst Zeitschrift (AFZ-Frageforum), 482-483. (No date).

Production of oxygen through photosynthesis is one of the most important functions of forests. This study attempts to analyze the problem quantitatively. To date, there is no method known to study oxygen production directly. However, it is possible to measure the amount of CO_2 that is assimilated. Therefore, the following equation is used to extrapolate from the known CO_2 consumption to the unknown O_2 production.

$$6\ CO_2 + 6\ H_2O + 675\ cal \rightleftharpoons 6\ O_2 + C_6H_{12}O_6$$

The computation is used based on the example of a 76 year old pine stand, and the following values are tabulated: annual CO_2 assimilation and O_2 emission per $10^4\ m^2$ forest; same value for a single tree; daily O_2 emission during main vegetation period.

190 kg O_2/day/hectare

Source: 6

#902
Bazzaz, F. A., G. L. Rolfe, and P. Windle. "Differing sensitivity of corn and soybean photosynthesis and transpiration to lead contamination." J. Environ. Quality, 3(2):156-158 (April-June 1974).

The effect of lead contamination of the photosynthesis and transpiration rates of corn and soybean plants was investigated. The plants were grown in media containing a range of Pb concentrations, supplied as lead chloride, and showed a decrease in activity with increasing Pb treatment levels. At lower Pb treatment levels, corn appears to be more sensitive than soybeans. At high treatment levels (62.5-150 mg/plant) soybeans are more sensitive than corn. At 250 mg Pb/plant in the medium, photosynthesis is only 10% of maximum soybeans, but 475% in corn, even though corn Pb tissue content is much higher than that of soybeans. Transpiration exhibited similar trends to photosynthesis suggesting that, especially in corn, an appreciable part of the inhibition of the two processes is related to increased stomatal resistances with increased Pb concentrations. Lead accumulation trends were similar at treatment levels of 0 to 62.5 mg/plant, but were slightly different at higher levels. The total amount of Pb accumulated was higher in corn than in soybeans. Maximum accumulated was higher in corn than in soybeans. Maximum accumulation in both species occurred at 62.5 mg Pb/plant.
Source: 1

#983
Barry, P. J., and A. C. Chamberlain. "Deposition of iodine onto plant leaves from air." Health Phys. 9:1149-1159 (1963).

The effect of light intensity and relative humidity on the absorption of airborne I-131 in tracer concentrations onto the attached leaves of broad bean (Vicia faba) was determined. It has been shown that the rate of absorption onto leaves is controlled by the rate of diffusion of the gas through stomata on the leaf surface. The relative humidity is the most important factor in determining the deposition. In dry air the rate was a tenth or less of that in humid air.
Source: 5

#161
Bartells, G.C., Jr. "Disappearance of sulphur dioxide from dilute mixtures of sulphur dioxide with air." Bull. Bureau Mines, 98:308-323, 503-520 (1915).

Experiments to determine the rate of disappearance of sulfur dioxide from mixtures of SO2 and air in a closed glass carboy showed that SO2 disappeared very rapidly and almost completely when in contact with green vegetation. This was due to simple absorption of SO2 by the live plant and to a small degree, to the oxidation of SO2 in an excess of moist air and the adsorptive property of the glass. When a mixture of SO2 and air in a glass container was exposed for a considerable period in a dry atmosphere in diffused light, only about 10% of the SO2 disappeared within 30 hr. This was due in part to oxidation of SO2 during prolonged contact with air, partly to loss by diffusion, and partly to the adsorptive property of the glass. When SO2 was mixed with air containing moisture to the point of 100% saturation, the rate of disappearance of SO2 was much greater and the disappearance more nearly complete than under any other conditions. This was due mostly to the adsorption of SO2 on the glass surface. Disappearance of SO2 from a mixture of SO2 and air exposed to direct sunlight was gradual, the rate of disappearance being greatest when the temperature in the carboy was highest. A part of the SO2 was adsorbed, the amount varying with the amount of water present. In all tests, both oxidation and absorption took place. Each occurred to a greater degree in moist air.
Source: 1

#899
Baum, F. "Ermittlung von Fluorschaeden an einer Lindenalle in unmittelbarer Naehe einer Ziegelei bei Ismaning durch Blattanalysen und Luftaufnahmen in Falschfarbentechnik." (Determination of fluorine injuries on an alley of linden trees in the immediate proximity of a brick kiln near Ismaning by leaf analyses and aerial infrared photography). Gesundh.-Ingr., 95(9): 259-263 (1974).

Upon discovery of severe leaf injuries in an alley of linden trees near Ismaning (Munich, West Germany), leaf samples were taken from the lower branches of the trees at three different time periods. The samples were dried, ground, and ashed according to the method by Buck (ashing of 5 g dry substance in a nickel vessel at a temperature of 450 to 500 C in a muffle

#901
Bazzaz, M.B. and G. Bazzaz. "Effects of lead chloride on chloroplast reactions." Environ. Letters, 6(3):175-191 (1974).

The effects of lead chloride on chloroplast reactions were investigated at various pHs. In maize chloroplasts, PbCl2 causes inhibition or stimulation of photosystem II activity depending on the pH of the reaction media. At pH 7.8, an inhibition of 16-39% with 0.75 nM to 9mM PbCl2 is observed. At pH 6.5, however, a stimulatory effect of 20% is observed with 9 mM PbCl2. This effect is not due to the uncoupling of photophosphorylation, or to the ability of PbCl2 to donate electrons to photosystem II. It is suggested that there is a common site of inhibition between water and Z (the primary electron donor of photosystem II) for lead treatment and Triswashing of chloroplasts. Lead salts at both pH 6.5 and 7.8 induced about 20% inhibition of the variable chlorophyll a fluorescence even in the presence of 10 micrometer 3-(3.4 dichlorophenyl)1, dimethylurea. Room temperature and 77 K chlorophyll an emission spectra show an increase in the ratio of pigment system I to II fluorescence upon the addition of lead salts at both pHs -- an effect opposite to that induced by salts of other divalent ions. Lead salts (0.9 mM to 9 mM) cause 10 to 20% increase in the 540 nm absorbance change, reflecting a decrease in spaces between thylakoids, over that of untreated chloroplasts. Lead-induced conformational changes in thylakoid membranes of chloroplasts, leading to changes in energy distribution between pigment systems I and II, is suggested to explain the above results.
Source: 1

#1155
Beale, J. A. "Forestry in the environmental decade." Adapted from a speech delivered at the Northeastern Area State Foresters Meeting, St. Paul, MN. (July 13-16, 1970).

This paper deals with the fact that forestry is in trouble. The main thrust of forestry must be directed in new directions. Forestry does not mean just wood production any more. Forestry in urban areas is becoming more important. Types of competence for foresters in the 1970s are listed. One of these includes competence in matters affecting the environment. Roles of forestry in the 1970s is reviewed.
Source: 6

#1093
Beavington, F. "Heavy metal contamination of vegetables & soil in domestic gardens around a smelting complex." Environ. Pollut., 9:211 (1975).

High levels of copper, zinc, lead, cadmium, nickel, and iron are reported in leaf vegetables in domestic gardens in close proximity to the copper smelter in Wollongong, New South Wales, Australia. Mean levels (dry matter weight) of lead, cadmium and nickel in lettuce are 23 ppm, 4.5 ppm, and 2.7 ppm, respectively. Easily-extractable levels of heavy metals in the supporting soil are also high. Significant correlations exist between distance from the main chimney of the smelter and the levels of a number of the metals in both soil and leaf vegetables (lettuce). In addition, highly significant correlations occur among the levels of most heavy metals in both soil and leaf vegetables.
Source: 1

furnace). The fluorine in the ash was determined by the method of Buck and Stratman. A relationship was determined between the fluorine concentration of the leaves and the location of the tree with regard to a brick kiln close to the alley. The severity of lead necrosis not only corresponded to the determined fluorine concentration but also to the gray tone of the infrared photographs. The results led to the initiation of measures for reduction of the fluorine emissions by this brick kiln.
Source: 1

#900
Baumeister, W. and H. Burghardt. "Untersuchungen ueber die physiologische Wirkung von Fluorid bei Tomaten und Spinat." (The physiological effect of fluoride on tomatoes and spinach). Flora (Jena), 144:213-228 (1956).

The effect of various concentrations of sodium fluoride on tomatoes and spinach was studied under conditions of hydroponic cultivation. The nutrient medium was a solution of 3 salts with Mn, B, Zn, and Fe as additives. In concentrations of 25 and 100 mg F/1 for spinach and of 50 and 150 mg F/1 for tomatoes, the effect was in all cases deleterious. The weights of the sprouts and roots, apparent CO_2 assimilation values, and pigment contents decreased while respiration intensity rose. Leaves yellowed at the tips; their rim dried up or curled up. At the higher concentration levels the plants died after about 4 weeks. At lower concentrations of 1, 5, 10, and 25 mg F/1 no effect on apparent CO_2 assimilation, respiration, and pigment content was noted. But while in the case of spinach the live weight of the plant was reduced by up to 40%, the weight of tomato plants increased by up to 60% and did not fall off sharply until a 50-mg F/1 concentration was reached. In tomatoes the roots, and in spinach the leaves, were most affected. The difference in the reaction of both species may be due to the circumstance that the tomato is free of fluorine while spinach is one of the fluorine-rich plants. Thus, at least on some plants, fluorine seems to have the effect of a trace mineral.
Source: 1

#162
Baumhardt, G. R., and L. F. Welch. "Lead uptake and corn growth with soil-applied lead." J. Environ. Quality, 1(1):91-94 (1972).

The effect of soil-applied lead on plant response, grain yield, and lead content of plants was examined in experiments with corn grown in a field where lead acetate was applied to the soil at 8 rates within 0-3200 kg/ha. Emergence, plant height, and grain yield were not affected by the added lead; neither were any morphological, color, maturity, or other growth differences visually observed. Added lead increased the lead content of stover; for the 0 and 3200 kg/ha treatment, respectively, lead values were 2.4 and 37.8 ppm for young whole plants, 3.6 and 27.6 ppm for whole plants at grain harvest. Grain lead content averaged 0.4 ppm and was not affected by added lead.
Source: 1

#917

Beitz, L. "Analyses von Schadstoffen in Pflanzen mit dem Roentgenfluoreszenz-verfahren." (Analysis of pollutants in plans with X-ray fluorescence). Chemiker-Ztg.(Heidelberg), 97(8):424-426 (Aug. 1973).

The X-ray fluorescent analysis of plants can be used to determine traces of toxic elements. The accuracy and limits of detection of these traces in dried plants are discussed. The analysis can be completely automated. Lead has been determined in plants near highways using this technique. The accuracy of the method is determined by the slope of the calibration curve and the measurement time. For the pollutants manganese, copper, zinc, lead, selenium, and arsenic which were in most cases present in concentrations between 1 and 10 ppm, near highways, the accuracy was between 1 and 10% relative. Systematic lead determinations in plant material (grass, leaves, and corn) showed a clear dependence of the lead concentration on the distance from streets and parking lots, on traffic density, and on the wind direction. In the grass taken from the dividing strip of the Autobahn Freiburg-Karlsruhe the average Pb concentration was 200 to 400 ppm. On parking areas near the Autobahn, it drops to about 20 to 50 ppm. In a meadow for cattle grazing 300 m away from the Autobahn, a Pb concentration of about 5 ppm was measured in the grass. Twice as much lead is accumulated in leaves as in grass. Source: 1

#903

Bell, J.N.B., and W.S. Clough. "Depression of yield in ryegrass exposed to sulphur dioxide." Nature (London), 241(5384):47-49 (January 5, 1973).

The effects of prolonged periods of low sulfur dioxide concentrations on the growth of ryegrass were investigated to determine whether SO_2 can cause visible injury and to measure the depression of yields at different concentrations. At a mean SO_2 concentration of 0.120 ppm for 9 wk, the yield decreased 13% in the leaf number, 22% in tiller number, and 8% in length of the third leaf. Overall yield reduction was about 46%. The plants were much smaller than those in the control chamber and were rather chlorotic. Source: 1

#918

Belot, Y. and D. Gauthier. "Mecanismes de transfert des particules microniques entre l atmosphere et les plantes." (Mechanisms of the transfer of particles in the micron range between the atmosphere and plants). Bull. Inform. Sci. Tech. Commis. Energ. At. (Fr.), 191:67-73 (April 1974).

The mechanisms of the transfer of particles in the 1-10 micron size range studied in a wind tunnel at wind speeds ranging from 1 to 20 m/sec using monodisperse fluorescein sodium and methyl blue aerosol was test substance, and Pinus sylvestris and oak twigs as capture elements. The rates of capture measured on Pinus sulvestris twigs ranged from 0.005 cm/sec for 2 micron particles at s cm/sec wind speed to 50 cm/sec for 10 micron particles at 10 m/sec wind speed. For oak leaves which assumed horizontal positions at wind speeds over 1-2 m/sec, the rates of capture measured for a size range of 2-5

micron were by 10 to 20 times lower than for pine twigs. The proportion of the aerosol settled on the woody parts amounted to 10-20% of the total amount deposited. The rate of capture was generally much higher than the rate of sedimentation at wind speeds over 1 m/sec. The rate of capture increased very rapidly with the wind speed. The findings indicate that the rate of transfer of fine particles is highest for fibrous leaves or small-diameter twigs.
Source: 1

#171
Belot, Y., J. Ridelle-Berger, and D. Gauthier. "La captation des particules atmospheriques par les feuilles des plantes. Essais en soufflerie." (The capture of atmospheric particles by the leaves of plants. Wind tunnel experiments. Commis. Energ. At., Bull. Inf. Sci. Tech., 151:9-14 (1970).

An experimental study was conducted to determine the uptake by pine needles of uranium particles with an average diameter of 0.1 micron. The pine branch was introduced into a wind tunnel in which the test aerosol was circulated. Pickup velocities approached .04 cm sec-1. Horizontal plates had a much smaller pickup velocity. Thus, pine needles seem well suited to air cleaning and may also be used as control samples for pollution detection and analysis.
Source: 1

#904
Benedict, H. M., D. D. Davis, and A. S. Heagle. "Dose responses of vegetation to minor air pollutants." (Presented at the Air Pollution Control Association Annual Meeting, 67th, Denver, Colorado, June 9-13, 1974, Paper 74-229.) Preprint, Air Pollution Control Assoc., Pittsburgh. 20 p. (1974).

Results of literature searches for the effects on vegetation of ammonia, cement-kiln dust, ethylene, chlorine, hydrogen chloride, hydrogen sulfide, and sulfuric acid aerosols reveal sufficient information to recommend an air quality standard only for ethylene designed to protect plants. Levels of fumigation (concentration and time) which would affect plants are found for all pollutants, but sufficient studies have not been made to warrant recommendations for air quality standards based on vegetation effects. In presenting the dose responses of vegetation to the various pollutants, the standard developed based on their effects primarily on humans are also presented. Except for sulfuric acid aerosols and hydrogen sulfide, the exposures which will affect vegetation are less than those considered acceptable for workers in industrial operations.
Source: 1

269

Benedict, H.M. and J.P. Nielsen. "The markings produced by various air pollutants on leaves." Proc. Nat. Shade Tree Conf., 32:205-214 (1956).

External effects of air pollutants on the leaves of various plants include inert or insoluble dusts clogging the stomata and inhibiting light or food, and markings due to corrosive substances, e.g. sulfur trioxide. Internal effects are those caused by absorption of polluting gases or soluble particulate matter into the leaves. Both types of effects, and the characteristic markings caused by exposure to ammonia, chlorine, hydrogen sulfide, nitrogen oxides, chlorine dioxide, sulfur dioxide, hydrogen fluoride, and smog are discussed.
Source: 1

#164

Benedict, H. M., J. M. Ross, and R. W. Wade. "The disposition of atmospheric fluorides by vegetation (final report)." Standford Research Inst., South Pasadena, Southern California Labs., 28 pp., (April 1963).

Alfalfa, orchard grass, chard, endive, spinach, and romaine lettuce were grown in sand culture and fumigated with hydrogen fluoride in the atmosphere at concentrations primarily under 1.0 microgram/cu m. The fumigations were continuous for periods as long as 4 months. Under the conditions of the experiments, no significant effects of the fluorides were found on the growth of aboveground portions of the plants as long as the leaves did not develop any markings ascribable to the fluorides. The results indicated that the growth of the roots may have been suppressed slightly by the fumigations. Additional studies are needed to verify this result. Analysis of plant organs and tissues indicated that the fluorides were taken in by the leaves or chlorophyll-bearing tissue (stems of alfalfa) and translocated to the leaf extremities. No evidence of downward translocation was found.
Source: 1

#165

Benedict, H.M., J.M. Ross, and R.H. Wade. "Some response of vegetation to atmospheric fluorides (final rept.)." J. Air Pollution Control Assoc., 15(6): 253-255 (June 1975).

A study was made of the effects of environmental conditions on fluoride uptake from the atmosphere and of internal fluoride on cell wall permeability. The significant results obtained indicated that alfalfa plants fumigated with hydrogen fluoride at night accumulated fluoride about as rapidly as plants fumigated during the day for the first three days. However, most of the fluoride accumulated at night could be washed off the plants, indicating it was adsorbed on the surface rather than taken into the plants. After three days, the plants fumigated during the day showed a much more rapid accumulation of fluoride than those fumigated at night. When the roots of plants are maintained in water cultures at 30 C, the uptake of atmospheric fluoride by the tops was much less than when the roots were held at 20 C even though the air temperature surrounding the tops of the plants was identical. The results suggest that additional studies on temperature effect on fluoride uptake by vegetation would be a fruitful field of investigation. Preliminary results indicate that the cell walls of plant tissues which have absorbed fluoride from the atmosphere have an increased permeability to solutes, based on electrical resistance of water extracts. Again, further study is needed to verify this point.
Source: 1

#905
Bennett, J. H. "Effects of ozone on leaf metabolism." Utah Univ., Salt Lake City, Dept. of Biological Sciences, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 106 p. (August 1969).

The effects of ozone on leaf intermediate metabolism were investigated. Deviation from a specified steady state condition and deviation from a forced change in the metabolic direction were used to assess ozone induced effects on the leaves of pinto beans. Pinto bean leaves were most sensitive to ozone injury 11-15 days after planting. The sugar levels were relatively low, amides and amino acid levels were high, and organic acid levels were increasing at the time of maximal sensitivity. In all the experiments, ozone damaged leaves increased their metabolite levels. Acute effects of ozone were manifested by an accumulation of water in leaf intercellular spaces and various degrees of foliar wilting. Moderate effects were characterized by some degree of tissue destruction.
Source: 1

#67
Bennett, J. H., A. C. Hill. "A model for gaseous pollutant sorption by leaves." (Presented at the 64th Annual Meeting of the Air Pollution Control Assoc., N. J., 1971.)

A model simulating pollutant exchange with isolated leaves chat integrates factors which have been found to be important in regulating pollutant uptake by plan·s is presented. The model is patterned after an electrical analogue simulator, applies to both amphistomatous and hypostomatous leaves, and was designed to emphasize the effects of pollutant properties on the sorption process. The paper discusses the significance of diffusional resistance (which may be affected by some pollutants that can cause stomatal closure), leaf surface sorption of pollutants, and pollutant solubility and fate on the uptake process. Data is presented showing uptake of ozone by exposed mesophyll and several epidermal surfaces chosen for their different surface characteristics. The model was used as the basis for deriving a mathematical expression for the transfer process which was rearranged to define average internal pollutant solute concentration in terms of external concentration, leaf and boundary layer diffusional resistance, surface sorption and pollutant solubility. The importance of obtaining an estimate of internal solute concentration is discussed.
Source: 6

#163
Bennett, J. H., and A. C. Hill. "Inhibition of apparent photosynthesis by air pollutants." J. Environ. Qual., 2(4):526-530 (October-December 1973).

The reversible effects of hydrogen fluoride, sulfur dioxide, and chlorine exposures on net carbon dioxide absorption rates (apparent photosynthesis) of alfalfa and barley plants were investigated. Carbon dioxide uptake was reversible suppressed by exposure dosages of these pollutants which did not cause cellular destruction in the leaves. Some necrosis resulted, except for the nitrogen oxides, from treatments which depressed CO_2 uptake rates

more than 25-60% by the end of 2-hour fumigation trials. The six air pollutants can be ranked in the following descending order according to the relative amounts that plant CO_2 uptake rates were depressed by the end of 2-hour exposure: HF, ozone, C_{12}, SO_2, nitrogen dioxide, nitric oxide. The phytotoxicants ranked in essentially the reverse order when compared on the basis of the rapidity that CO_2 uptake was suppressed as a function of exposure time. Nitric oxide treatments caused very rapid reductions in the plant CO_2 uptake rates during the first hour of exposure. By this time, plant uptake rates had attained new (depressed) steady state equilibrium levels which were then maintained over the remainder of the exposure periods. Hydrogen fluoride treatment induced more gradual reductions in plant CO_2 uptake rates throughout the test periods. Plant responses to the other pollutants, SO_2, NO_2, C_{12}, and O_3 were intermediate between those caused by NO and HF.
Source: 1

#1413

Bennett, J. H., and A. C. Hill. "Interactions of air pollutants with canopies of vegetation." Chapter 12, Response of Plants to Air Pollution, J. B. Mudd/ T. T. Kozlowski (ed.), Academic Press, New York (1975).

Purpose is to describe interfacing interactions between plant canopies and major gaseous pollutants in the air in the immediate vicinity of the vegetation. A general intro. on cycling of atmospheric components with vegetative biosystems is presented briefly. Then there is a discussion of gaseous pollutant interchange between simple plant canopies and adjacent canopy boundary air layers and of the plant sink sites and pollution fate within the vegetation. Reference model exchange systems applied to simple uniform canopies are employed in the treatment of the subject material.
Source: 7

#105

Bennett, J. H., A. C. Hill. "Absorption of gaseous air pollutants by a standardized plant canopy." J. Air Pollut. Control Assoc., 23(3):203-206 (1973).

Concentration profiles for HF, SO_2, O_3, NO_2 and NO generated in standardized alfalfa canopy are presented. Wind, light, temperature and CO_2 profiles, canopy pollutant uptake rates, and canopy structural data are also given. Canopy pollutant concentration profile characteristics were studied to evaluate the relative potentials for major air pollutants to penetrate into canopies. The study was conducted in an environmental growth chamber equipped to control automatically environmental conditions and monitor continuously gas exchange rates. HF, SO_2, NO_2 profiles suggested that these gases were removed efficiently by the upper portion of the canopy as well as by the immediate subsurface vegetation. The steady state HF profile showed the greatest displacement within the canopy. The NO profile was displaced the least. The uptake rate of NO by plants was apparently too slow in comparison with gas transport and mixing within the canopy to affect the internal profile substantially. O3 appeared to be readily deposited on the surface tissues; but the deeper tissues in the canopy had less effect on the concentration profile. Data are also presented to show the relationship between NO_2 concentration within the canopy and changes in the air concentration above the vegetation. The results indicated that gas transport between the atmosphere and canopy interior was rapid.
Source: 6, 7

#18
Bennett, J. H., and A. C. Hill. "Interaction of gaseous air pollutants with canopies of vegetation." Agricultural Environmental Quality Institute, NE Region Agricultural Research Service, USDA, Md.

A general description of vegetation (in the global sense) and its relation to the environment. Role of internals and external plant organs and the chemical changes affected by pollutants at the cellular level are discussed. From a review of literature it was determined that the movement of air pollutants to vegetation surfaces depends upon factors which affect the particulate transfer and the properties of the particulate and the receiving vegetation. Weather conditions such as temperature and wind influence settling and absorption of thepollutant. Mathematical equations describe varying physical conditions of the airflow and pollutant.
Source: 8

#533
Bennett, J. P., B. M. Resh, and V. C. Runeckles. "Apparent stimulations of plant growth by air pollutants." Can. J. Bot., 52(1):35-41 (January 1974).

A survey of recent literature on the effects of low levels of air pollutants on plants, and the results of our experiments with low levels of ozone (<0.1 ppm) on bean (Phaseolus vulgaris), barley (Hordeum vulgare), and smartweed (Polygonum lapathifolium) indicate stimulations of various growth parameters when compared with growth in clean, filtered air. Increasing knowledge of the composition of air in various regions of the world has been interpreted by some as evidence of increased air pollution. We argue that such a conclusion may not necessarily be valid, and that the observed levels of individual constituents may be indicative of long-term composition. The similarity between the ambient levels of pollutants reported from numerous locations and those which result in stimulations of plant growth when compared with clean air, suggests that plants exhibiting such stimulations have adapted to low pollution levels, and hence are at a disadvantage when grown in clean air. We argue that the use of filtered air controls in experiments on the effects of air pollutants on plants is therefore unrealistic and misleading, and should be replaced by the use of ambient levels of pollution.
Source: 2

#922
Berge, Helmut. "Immissionsschaeden an landwirtschaftlichen und gaertnerischen Kulturen." (Emission damages on agricultural and garden plants). Immissionsschaeden (Berlin), 1-23 (1958).

General problems of emission damages to agricultural and forest plants are surveyed with special regard to sulfur dioxide inflicted damages, and methods for the study of such damages are evaluated. The susceptibility of plants to specific pollutants is dependent on a variety of factors such as temperature; humidity and moisture content; light conditions; wind; site; exposure; slope; the physical, chemical and biological properties of the soil; and the influence of other plants, animals, and man. Pot experiments with test plants can not be applied to practical conditions concerning the effects of air pollutants on plants. In the light of recent studies, acute damages of external and/or internal plant parts, direct chronic effects resulting in

functional troubles, and indirect chronic effects with manifestations in production and growth loss are distinguished. Particulate matter settling on leaves can act chemically and/or physically, depending on its composition, absorption, and solubility. It depresses assimilation, but it may also have beneficial effect during drought. Settling dust can also affect plants through the soil. Many plants are damaged by SO2 concentrations as low as 0.3-0.5 mg/cu m. Apart from the number of stomata, the degree of opening of the stomata is of particular influence on the amount of the emission damages. The opening of the stomata is increased by such factors as temperatures above 5 C, abundant moisture supply, high relative humidity, and high light intensity. Plants are usually more resistent to sulfuric acid than they are to SO2.
Source: 1

#44
Berge, Helmut. "Durch Schwefeldioxyd bedingte Immissionschaeden as Obst- und Waldbaeumen." (Injury to fruit and forest trees from sulfur dioxide emissions). Gartenbauwissenschaft, 24(2):220-228 (1959).

Observations and sulfur dioxide emission-control tests in the northeastern industrial area of North Rhine-Westphalia showed that under certain conditions plant analysis provides important evidence in diagnosing smoke damage. The threshold values for SO_2 noxiousness claimed by some authors can only be applied on such a wide range that their usefulness is questionable. Schedules covering the sensitivity of plants are only of local and temporary value, due to the effects of ecological and meteorological conditions and species variation. Differences in the sensitivity of species and varieties of fruit and forest trees are discussed. A number of examples show that parasitic attack or diseases increase SO_2 absorption and/or symptoms of smoke damage. For several tree species, including apple, pear, plum, scotch pine, mountain ash, and beech, the seasonal total content of sulfur (expressed as SO_2) in the foliage is shown in curves, which are in good agreement with an earlier study.
Source: 1

#758
Berge H. "Hydrochloric acid, bromine, iodine, hydrogencyanide, ethylene, carbonmonoxide, mercaptans, coal gas, asphalt and tar vapors, saturated hydrocarbons, acetic acid, 2,4-dichloro-phenoxy-acetic acid, mercury, selenium, smoke and fog." In: Phylotescische Immissionen, Berlin, Parey. Translated from German. p. 51-71 (1963).

Occurrence of the contaminant, its macroscopic and microscopic damage to plant organs, its mode of action, and its diagnosis are summarized, along with differences in resistance among plants for the following: hydrochloric acid, bromine, iodine, hydrogen cyanide, ethylene, carbon monoxide, mercaptans, coal gas, asphalt and tar vapors, saturated hydrocarbons, acetic acid, 2,4-dichloro-pheonxy-acetic acid, mercury, selenium, smoke and fog, and sulfuric acid.
Source: 1

#406

Berge, H. "Immissionempfindlichkeit der Laub- und Nadelhoeizer in Abhaengigkeit von Standortfaktoren." (Sensitivity of leafed trees and conifers to immissions in dependence of location factors). Text in German. Allg. Forstz., 6:90-91 (1969).

Trees of the leaf type as well as conifers can, under certain circumstances, be exposed to the hazards of air pollution imissions combined with indirect damage from mining operations in neighboring areas. This occurs particularly in cases of changes in the level of the ground water table. If the water table rises considerably, e. g., to about 0.50 m below the soil surface, it may draw nutrients away from the soil under the trees and thus decrease the resistance of the trees to damage by such air pollutants as sulfur dioxide. Conversely, depending on the chemical composition of the water, it may in such a case add nutrients and thus benefit the trees. Undermining can cause a decrease in soil porosity which in turn can lead to increased sensitivity of the trees to phytotoxic immissions. A 60-year old pine forest is described which had been exposed over the years to immissions of hydofluoric acid, causing typical damage symptoms without endangering their survival. However, when in one particular year level of the water table dropped from 2.6 to 4.2 m from pumping operations in a nearby mining area, the pines virtually died. Other examples are included.
Source: 1

#920

Berge, H. "Differentiation and evaluation of air pollution from a botanical point of view. Environ. Pollut., 1(2):141-147 (1970).

The effect on vegetation of various gases, smoke, and dust depends on internal plant structure, surrounding conditions, and also on such pollutant characteristics as power of absorption, acidity or alkaline qualities, oxidizing or reducing effects, hormone effects, and toxic effects. These activities can be properly assessed only by the control of emissions. However, maximum permitted 24-hr. emission concentrations (the MIC values) vary so from country to country and within a single country that satisfactory comparison and assessment of pollution damage is difficult. Terminology to distinguish between the various kinds of emissions affecting the animate and inanimate world is discussed. Examples of combined plant damage due to pollution from mining accompanied by changes in water-ground level are given. When plants are included in measurement of pollution, it is possible to test the validity of single toxic limit values for particular gaseous mixtures because combined and cumulative effects produce specific signs whose physiological, chemical, anatomical, morphological, or genetic characteristics can be recognized.
Source: 1

#419
Berge, H. "Beziehungen zwischen Baumschaedlingen und Immissionen." (Relationship between tree pests and imissions). Text in German. Anz. Schaedlingskunde, 46:155-156 (1973).

In a forest in the vicinity of a large sulfur dioxide emission source, lice were discovered on the species abies concolor and abies veitchi mainly on those needles where injuries from SO_2 and hydrogen fluoride exposure were macroscopically and microscopically visible. All abies species whose new shoots were treated with a pesticide until the second half of May showed no injuries on the new 1-year old needles. Non-treated trees showed either injuries or dropped the needles. Contrary to this, mealy bugs on pinus griffithi, pinus silvestris fastigiata and pinus silvestris pumily were mostly found on the non-injured needles and not on those showing macroscopic and miscroscopic SO_2 injuries. Species of llex aquifolium uninjured by SO_2 suddenly displayed acute injuries after they had been heavily attacked by the fly phytomyza ilicis which coincided with HF concentrations of 6 to 8 micrograms/cu m and half-hourly values of SO_2 of 1.5 to 2.0 mg/cu m. Only those treated with an 0.4% Wuxal-solution (six times in 14-day intervals) showed no injuries. Similar results were obtained with a spider mite (oligonychus ununguis) on picea omorika. Through treatment with pesticide, the pests and plant injuries could be averted. The sacchiphantes viridis louse was found in greater concentrations on parts protected from exposure by walls or other plants. The blastehia turionella on pinus mountana occurred most frequently on heavily injured parts. The extent of pest occurrence among other things was influenced by weather, season, climatic, orographic, and topographic factors. Through efficient pest control, some injuries can be avoided.
Source: 1

#921
Berge, H. "Plants as indicators of air pollution." Toxicology (Netherlands) 1(1):79-89 (March 1973).

In that neither humans nor domesticated animals are reliable indicators, plants are becoming more and more important in the objective evaluation of a health environment. A large variety of annual and perennial plants can provide an opportunity to investigate, in a statistically satisfactory manner, the influence of air contamination on natural regions. However, biological indicator methods are not yet sufficiently developed to satisfy the needs of regional air quality control planning, there are too many climatic, topographical, edaphic, and biotic factors which may affect the reaction of the same indicator plant within different areas of the same region and during different seasons. It is also impossible to estimate precisely the future effects of new industry using only test plants. Nonetheless, in every region, distinct indicator plants should be sought which would best react under the prevailing circumstances to a change, and especially to a negative, emission situation. Test plants should be selected which are suitable for each particular emission situation, country, and district. Special preference should be given to evergreen perennial plants such as conifers and rhododendrons.
Source: 1

#405
Berge, Helmut. "Emissionen und Immissionen in der Land- und Forstwirtschaft." (Vegetation and air pollution). PEP (Prod., Ertrag, Profit), 2:1-6 (1974).

A general description is given of the effects of air pollutants on vegetation in agriculture, horticulture, sylviculture, and the significance of plants and especially of forests in air pollution abatement is discussed. Smoke damages to plants can be determined quantitatively or qualitatively and examined progressively. Exposure to hydrochloric acid in the air caused chloroplast damages in Picea Pungens, and inactivation of the pesticide Dupha by alkaline loess settling on rose leaves was observed. Serious damage to plants due to city gas in the air or in the soil due to leaking pipes was found. Plant damages due to ammonia emissions from a pig farm were determined. Vegetation, especially trees in green belts and in median strips of highways are valuable in that they produce oxygen and filter out particulate air pollutants.
Source: 1

#1217
Berge, H. "Auch vos Rauch und Gasen schützt der Wald." (The forest protects against smoke and gases - The relationship between forest and air pollution). Agrikulturchemisches Institut (Dusseldorf), 3 pp. (No date).

Some general and brief examples are given of how forests can reduce gas, smoke and dust pollution. The paper calls for the conservation of existing forests and the creation of new forests in the vicinity of all industrial areas.
Source: 6

#145
Bergen, J. D. "Air movement in a forest clearing as indicated by smoke drift." Agricultural Meteorology, 15:165-179 (1975).

Cinematic observations were made of the behavior of multiple smoke plumes in an isolated clearing cut in an even-aged stand of lodgepole pine. The clearing was 10 m by 80 m, and the average tree height was 10 m. Measurements were made against a tower grid with simultaneous recording of the windspeed and direction above the canopy. Observations are discussed for times when the latter was within 30° of being perpendicular to the long axis of the clearing. Horizontal velocities for some portions of the clearing were estimated from the frame-to-frame displacement of plume irregularities. Vertical velocities were computed by continuity.

The results indicate a continuous alternation between separated and unseparated flow with the frequency of alternation in the fair agreement with the eddy shedding frequency of the lee canopy region of the clearing regarded as flatplate in uniform flow. The flow sequence includes a central vortex which closely resemble in form that found in square notches but with higher angular velocities relative to the upwind friction velocity. This vortex appears to dominate the distribution and direction of the maximum speeds and surface shear stress in the clearing.
Source: 7

#1097
Berindan, Cornelia. "Interrelation pollution atmospherique et espaces verts en tant gue principe protecteur des villes industrielles." (Inter-relation between air pollution and open spaces, as a principle for the protection of industrial urban centres). Pollut. Atmos. (Paris), 11(43):143-153 (July-Sept 1969).

Legal and administrative aspects, effects-plants and livestock: Residential areas, planning and zoning, plant pollutant retention.

The use of vegetation for the protection of residential areas from air pollutants emitted by neighboring industrial plants is reviewed. A table listing the principal (smog and its constituents), secondary (aerosols and oxides) and other gaseous aerosol, or particulate pollutants is given. Pertinent research concerns the effect of polluted air on vegetation, and the effect of vegetation on atmospheric air, particularly on polluted air. A table of phytotoxic effects of industrially polluted air is provided with respect to 267 subspecies of plants, as rated in Romania, Poland, USSR, Germany, Holland, Bulgaria, Austria, and Sweden. The capacity of retaining airborne dust by 12 species of trees is also tabulated. The capacity of plants to retain pollutant gases is discussed. The aerodynamic effects of tree plantings and their role in dust retention and as wind deflectors are pointed out. Illustrations of the use of green belts for protection of residential areas from polluted areas from polluted air based on studies made in the United States, Holland, Czechoslovakia, and Rumania are given. General principles which govern the layout of protective zones of vegetation in industrial urban centers are provided.
Source: 6

#1963
Berindan, C. "Interrelation pollution atmospherique et espaces verts en tant que principe protecteur des villes industrielles." (Atmospheric pollution interrelation and green spaces as a protective principle of industrial towns). Tribune CEBEDEAU (Centre Belge Etude Doc. Ezux), 301:143-153 (July-Sept. 1969).

The protection of residential areas from air pollution due to industrial sources, by means of green plantings, is discussed. Plants intended for such protective zones should be resistant species and they should act on the atmosphere. The pollutants known for their phytotoxic properties are presented in tabular form. The action of plants on air polluted by dusts consists of decreasing the wind speed, collecting the dust on the leaves, and acting on the local air movement. The plants found to be resistant to pollutants are also listed in tabular form. The retention of sulfurous gas, fluorine, hydrogen sulfide, and nitrogen oxides has been established. A correlation between the type and concentration of the pollutant and the degree of plant resistance is needed when managing green spaces for sanitary protection. For each situation, the degree of toxicity of the pollutants should be known in order to choose species with a specific resistance. Plantings with an aerated structure, obtained by grouping wind breaks or rows of trees, retain dusts and gaseous pollutants better than compact areas. Methods which are recommended for determining the form of future protective zones include zoning the values of pollutants obtained by ground studies, mathematical processes based on the laws of pollutant dispersion, and graphic processes.
Source: 1

#1959
Berindan, Cornelia. "Oeffentliche Gruenflaechen in Staedten mit Luftverunreinigung Augenblicker und Zukenftiger Stand." (Public open spaces in polluted cities). Mitt. Forst. Bundesvers., 97:541-567 (1972).

To study the development of industrial cities, the green open spaces in five Rumanian towns with sources of industrial pollution were investigated. The individual structures of these open spaces were analyzed in terms of high, medium, and low plants and the primary species present. On the basis of the town planning projects, a scheme for the future development of the green open spaces was devised. To establish the growth conditions of the plants, an inventory was made of the pollution due to the chemical, metallurgical, and cement industries, together with specification of their respective pollutant emissions. A pollution spectrum was obtained in which sulfur dioxide was the principal phytotoxic agent. The extent of the polluted areas was also determined. The data show the unfavorable growth conditions of the plants studied, with the trees and plantings being primarily affected and certain flowers being unaffected. Proposals are made for the planning of large areas covered with flowers as a means of improving the well-being of the residents of the industrially polluted communities.
Source: 1

#1964
Bernatzky, A. "Die Bedeutung von Schutzpflanzungen gegen Luftverunreinigungen." (The importance of protective plantings against air pollutants). Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 383-395 (1968).

As indicated by a review of the literature, forest belts do not solve the problem of air pollution but, when properly planned, will facilitate the reduction of air pollutants. Though generally ineffective in the case of sulfur dioxide, pollution-resistant species reduce atmospheric concentrations of dust and of solid and gaseous radioactive substances. In addition, they reduce noise, prevent binding of SO_2, and increase the relative humidity of air. Solid particles can be filtered from the atmosphere by planting open stands of trees or shrubs. Dense stands are needed for gaseous pollutants. In protective plantings, the longitudinal axes have to run across the prevailing wind direction. In areas without wind, e. g., towns, hot air ascends and relatively cold air pours in from all sides, leading to the accumulation of polluted air in the center that has to be filtered by concentric plantings. The closer the forest strips to the source of smoke, the greater their effectiveness.
Source: 1

#40
Bernatzky, A. "Schutzpflanzungen zur Luftreinigung und Besserung der Umweltbedingungen." (Protection plantings for air purification and improvement of environmental conditions). Presented at the Council of Europe Symposium on Air Pollution, Wageningen, West Germany. Bam-Ztg., 2(3):37-42 (1968).

The role of planned forestry and planting in air pollution and general environmental control is examined. Positive results were ascertained in the effects of protective planting on reducing the amount of particulate and solid and gaseous radioactive substances in the air, assimilation of carbon dioxide, noise reduction, and overall improvement of local climatic conditions and the entire living environment.
Source: 1

#1086
Bernatsky, A. "The importance of protective plantings vs air pollutants." (German, English, French summaries) In: Air Pollut. Proc. 1st Eur. Congr. on Influence of Air Pollution on Plants & Atmos., Wageningen (April 22-27, 1968). Center for Agr. Publ. & Doc., Wageningen, The Netherlands. Translated from German for APTIC by Belov & Assoc., Denver, Co. APTIC TR-0929. 415 p.

The importance of protective plantations in lowering air pollution.

Protective plantations cannot solve the problem or air pollution alone but they can substantially assist (1) if the right resistant plants are used, (2) if the plantations are established in the right manner, and (3) if the meteorologic and topographic conditions are taken into account.

Air pollution may be caused by solid particles that have to be filtered out, or by gases that have to be dispersed by directing the polluted air in a direction where it can do no harm, which usually means upwards.

Filtering can be carried out by planting of open stands of trees or shrubs in which the velocity of the wind decreases and the particles settle. But to stop gases, dense stands are needed. The area on which the latter are at most 5 times the height of the stand at the windward side, 25 times at the leeward side.

In protective plantations the longitudinal axes have to run across prevailing direction of wind. In areas without wind (e. g. in towns) the hot air ascends and relatively cold air pours in from all sides, leading to the accumulation of polluted air in the center that has to be filtered by centric plantations (at least theoretically; this is hardly ever practical).

Especially where several factories emitting both kinds of pollutants occur in the same urban area, planning protective plantations is a complex procedure. But it should be remembered that all forests and plantations are favorable by lowering the temperature, by increasing the relative air humidity and by creating local air-circulation areas in which the air may be considerably purified.
Source: 6

#1965
Bernatzky, A. "Gruenflaechen und Stadtklima." (Green areas and urban climate). Staedtehygiene (Uelzen/Hamburg), 21(6):131-135 (June 1970).

Facts showing the major changes in urban climate due to air pollution and the positive effects of green areas and trees are reviewed. Dust, sulfur dioxide, hydrofluoric acid, and carbon monoxide are the most dangerous air pollutants in urban atmospheres. Some 10-20% of the total solar radiation and almost the total ultraviolet radiation are absorbed by the polluted atmosphere over cities. Increased carbon dioxide levels, causing the well-known greenhouse effect, result in elevated temperatures in cities compared to their suburbs. The temperature differences may be 0.5-1.5 C on a yearly average, and more than 10 C in absolute values. Green areas and trees, though unable to eliminate the effects of pollution, have many advantages. Dust, including radioactive substances, are filtered out by trees in considerable proportions, and decreased wind speeds, by a minimum of 10%, can be observed. Radioactivity, measured on the lee side of trees, accounted for only 25% of that measured on the weather side. Trees absorb very high amounts of CO_2 and produce oxygen. Decreased temperatures in green areas are a fact. Temperatures up to 3.5 C lower over green areas, compared to adjacent areas, were measured. In addition, green areas are of great value from a psychic point of view.
Source: 1

#1156
Bernatzky, A. "Climatic influences of the greens and city planning." (Garden & Landscape Architect). pp. 29-33. (No additional info).

An essay on the importance of green areas in cities and due to uncontrolled growth and economics, the cities have a deficiency in green areas. There is a table of data depicting the average values of air pollution in large and small cities, oceans, mountains, country places, and coastal areas. Air pollution varies according to the time of day and the season as well as the altitude. Dust particles contribute to the formation of a dust dome which is responsible to decreases in sunlight in a city. The higher building of a city may aid in preventing natural flow of air. The masses of buildings of a city may store heat during the day. Statistics on the dimensions, biochemistry, and gas exchange of an eighty year old beech are given.
Source: 6

#907
Berry, C. R. "White pine emergence tipburn, a physiogenic disturbance." Southeastern Forest Experiment Station, Asheville, N. C., Div. of Forest Disease Research, Station Paper 130, 8 p. (September, 1961).

Emergence tipburn, a needle blight of eastern white pine attacks young developing needles in early summer. Evidence indicating that the cause of emergence tipburn is atmospheric and environmental in nature is presented and naturally occurring ozone is suggested as a likely causal agent. Root mortality is greater on diseased than healthy trees, but this is regarded as a result of the loss of foliage. Many fungi were isolated from the roots, but none were associated consistently with the dis-

ease and none was a recognized root pathogen. Diseased trees transplanted to an area of less disease severity were thereafter affected less than checks left in the area where the trees were obtained. Diseased and healthy scions were grafted to diseased and healthy stocks. Ninety-one percent of the surviving scions persisted in their original condition regardless of the condition of the trees they were grafted to. Typical disease symptoms were produced on susceptible ramets by artificially ozonating the plants at 10 pphm for 2 hours. Ramets from a tree unaffected in the field were unaffected by the same treatment. Abnormally high incidence of emergence tipburn and tobacco weather fleck occurred in early summer in North Carolina in 1961, suggesting the two diseases are caused by the same or related factors.
Source: 1

#906
Berry, C. R. "Eastern white pine, a tool to detect air pollution." Southern Lumberman, 209(2609):164, 166 (1964).

The use of Eastern white pine (Pinus strobus L.) as a sensitive air pollution indicator is described. There is a striking tree-to-tree variation among white pines in resistance or susceptibility toair pollution, implying that resistant seedlings might be raised in quantity and planted in polluted areas. It is also noted that different trees display a variety of symptoms in a given area, perhaps as a result of individual sensitivities of particular trees to a single gas in a mixed-pollutant atmosphere; such individual trees can be valuablein a pollutant analysis. It is known from experimental work that white pine can be injured by fairly low concentrations of ozone and sulfur dioxide, and by chlorine; mortality from automobile exhaust has also been observed:
Source: 1

#908
Berry, C. R. "Relative sensitivity of red, jack, and white pine seedlings to ozone and sulfur dioxide." Phytopathology, 61(2):231-232 (1971).

Groups of red pine, jack pine,and eastern white pine seedlings at ages 3, 5 and 7 weeks were exposed to individual dosages of 25 to 50 pphm of ozone and sulfur dioxide to determine their relative sensitivity. Jack pine was the most sensitive to ozone. None of the species was sensitive to SO_2 at the 25 pphm level. At the 50 pphm level, red pine was the more tolerant to SO_2. Ozone was more injurious to all three species than was SO_2.
Source: 1

#1100
Berve, Raghilt. "Air purification, objective pursued by physical planning in relation to urban agglomerations - example: the Ruhr." In: Second Int. Clean Air Congr. Proc. Held at Washington, D.C., 1970, H.M. Englund and W.T. Berry (eds.), Academic Press, New York, p. 95-99 (1971).

The writer points out the damaging effects of air pollution on the well-being of city dwellers and he stresses that city planning as well as legislation are vital to alleviate the problem.
Source: 8

#1844
Beytia, E., P. Valenzuela, and O. Cori. "Terpene biosynthesis: formation of nerol, geraniol, and other prenols by an enzyme system from Pinus radiata seedlings." Arch. Biochem. Biophys., 129(1):346-356 (January 1969).

The properties of a soluble enzyme system obtained from pinus radiata seedlings, which transforms 2-C-14-mevalonic acid (MVA) into C5 and C10 alcohols, were studied. The system incorporated 6 to 7% of the radioactivity from MVA into isopentenol, dimethy lallyl alcohol, nerol, and geraniol and required Mg (2=) or Mn(2=) and SH groups for optimal activity. Five and ten-carbon prenols are formed from the corresponding phosphorylated derivatives by a phosphatase, which may be partially inhibited by NaF. About 1% of the radioactivity from MVA remains bound to the proteins in an apparently non-covalent association. This radioactivity, which behaves mainly as C15 prenols, may be related to the biosynthesis of carotenes or phytol, and not to monoterpenes. It can be extracted with 1-butanol. The identification of C-14-isopentenol in a hexane-soluble fraction, after incubation of the enzyme system with MVA, suggests that isopentenyl pyrophosphate (IPP) is hydrolyzed by an acid phosphatase. Dimethyl allyl alcohol, identified in the same fraction, is probably formed by enzymic hydrolysis of dimethy allyl pyrophosphate (DMAPP). The sensitivity of the isomerization of IPP to DMAYP. Formation of geraniol and geranyl pyrophosphate (GPP) is probably related to the biosynthesis of diterpenes, carotenes, and phytol. There is no evidence that GPP is the precursor of monoterpenes.
Source: 1

#166
Bidwell, R. G. S., and D. E. Fraser. "Carbon monoxide uptake and metabolism by leaves." Can. J. Botany, 50(7):1435-1439 (1972).

The mechanisms of carbon monoxide uptake and metabolism by bean leaves were studied. In light, CO was converted mainly to sucrose and proteins. The distribution of carbon-14 among the products suggested that most of the absorbed CO was reduced and incorporated into serine which was converted to sucrose. Some CO was oxidized to carbon dioxide, part of which may have been refixed as such in photosynthesis. In darkness, CO was absorbed nearly as fast as in light, but was almost completely converted to CO_2 and released. Light CO fixation rates varied between 0-0.25 micromole/sq dm/hr, were roughly proportional to CO concentration, and were unrelated to photosynthesis rates. The CO reduced or abolished CO_2 fixation rates in some leaves. The CO fixation by vegetation of intermediate CO-fixing capacity was calculated to be 12-120 kg/sq km ground/day.
Source: 1

#303
Blakeslee, W. H. and L. R. Reckner. "Air pollutants." In: Air Pollution and Industry, R. D. Ross (ed.), Van Nostrand Reinhold Co., New York, Chapt. 4, p. 228-247 (1972).

Carbon dioxide, carbon monoxide, sulfur compounds, photochemical oxidants, and particulates are reviewed in terms of their physiological and pathological effects, and their natural or manmade sources. Carbon dioxide in-

creases resulting from the use of fossil fuels are responsible for the greenhouse effect, whereby the average temperature of the earth's atmosphere increases. The effect is opposed, however, by atmospheric smoke and dust, and concern over CO_2 pollution may be needless, considering its value to plant life. Carbon monoxide is the most ubiquitous pollutant gas in the world and results primarily from incomplete combustion of carbonaceous fuels. The molecule is capable of combining with blood hemoglobin in humans and blocking oxygen transport. Among sulfur oxides polluting the environment, sulfur dioxide is the primary industrial pollutant, with power utilities being responsible for over 50% of the SO_2 emissions. Aside from its plant-damaging capability, the molecule is capable of causing lung damage in humans when environmental conditions are favorable for sulfuric acid conversion. Photochemical smog resulting from the action of sunlight on the hydrocarbon and nitrogen oxide components of vehicle exhausts is irritating to the eyes and respiratory tract and can cause increased incidence of infection and disease. Ozone and peroxyacyl nitrates are secondary pollutants in the photochemical reactions. The optical and toxicological properties of particulate pollution are size-dependent. Possible sources are sea spray, dust storms, volcanoes, forest fires, automobile exhaust, photooxidation reactions, vegetation vapors, and industrial effluents. The toxicity of such particles also depends on their particular chemical composition.
Source: 1

#404
Blattny, C. and J. Brcak. "Die Bedrohung der Futterpflanzen durch Smog und Poa annua als Indikator dieser Schadquelle." (The threat to fodder plants by smog and poa annua as an indicator of this source of damage). Wiss Z. Karl-Marx Univ. Leipzig Math.-Natur. Reihe, 11(1):111-113 (1962).

Poa annua plants were placed 130 cm from an automobile tunnel to detect the presence of smog. The first nine plants were removed 54 hr after exposure, an additional nine plants after 102 hr, and the last nine plants after 126 hr of continuous exposure. After 54 hr, three plants showed yellowish-white stripes across the leaf blade. The symptoms corresponded to a smog concentration of 1.5 ppm. After 102 hr, symptoms were present on all plants. After 126 hr, all nine plants showed symptoms on many leaves; almost entire leaves were white-yellow in color or exhibited stripes of light tissue running across the leaves. The sensitivity of plants to smog is dependent not only on the intensity of exposure and temperature. Decreased water consumption increases the plant resistance. The damaging effect of smog occurs even at very low concentrations; a concentration of 0.1 ppm causes destruction of the green tissues. The formation of chlorophyll and the auxin effect are retarded with concentrations as low as 0.01 ppm.
Source: 1

#408
Bleasdale, J. K.A. "Atmospheric pollution and plant growth." Nature (London), 169(4296):376-377 (March 1 1952).

Rye grass grown in a greenhouse receiving purified air had a considerably higher dry weight than rye grass grown in a greenhouse receiving outside air containing 0.01-0.06 ppm sulfur dioxide. No sign of leaf damage was detected in the greenhouse with polluted air. Pollution thus appears to decrease growth rate, even in the absence of visible leaf injury.
Source: 1

#760
Bleasdale, J. K. A. "The effects of air pollution on plant growth." In: The Effects of Pollution on Living Material. Symp. Inst. Biol., 8:81-87 (1959).

In the United Kingdom, the most widespread and economically important air pollutant is sulfur dioxide-containing coal smoke. The smoke affects the environment for plant growth by reducing the amount of light available to the plants, by altering soil conditions, and by contaminating the air with foreign gases. In reducing the light available to plants for photosynthesis, smoke haze reduces their growth. The tarry deposit on leaves further reduces light and lowers the assimilation rate. Rain falling in or near an industrial area dissolves the predominantly acid polluting gases from the air and leaches bases from the soil. In increasing soil acidity, the rain reduces the number of soil bacteria and sometimes the availability of plant nutrients. There is evidence that gaseous pollutants affect processes involving cell division, namely the rates of tiller production and leaf formation. In addition, coal smoke and sulfur dioxide increase the rate of leaf senescence. The most serious effect of pollution is seen in farming, where pollutants make re-seeding of grassland impractical.
Source: 1

#414
Bleasdale, J.K.A. "Effects of coal-smoke pollution gases on the growth of ryegrass (Lolium Perenne L.)." Environ Pollt., 5(4):275-285 (December 1973).

Plants of S23 ryegrass were grown in soil of low fertility and in soil improved with fertilizers and exposed to sulfur dioxide, water-scrubbed air which removed 98-100% of the SO_2, and clean air. Plants grown in polluted air weighed 16-57% less than plants grown in similar air that had been scrubbed. Plants which were treated for part of each day with polluted air were heavier and had more leaves and tillers than plants grown continuously in either scrubbed or polluted air. In none of the experiments were abnormal leaf lesions observed, although leaf senescence was accelerated by polluted air. The SO_2 in polluted air was responsible for the observed effects; the enhancement of growth during intermittent treatment with polluted air was accounted for by postulating that the balance of partially oxidized and reduced sulfur radicals, known to control cell division, was affected. Since this mechanism of control is common to both plants and animals, it is possible that SO_2 could affect animal health by interfering with cell division.
Source: 1

#888
Blom, B.E. "Sorption of cadmium by soils." Cold Regions Research and Engineering Lab, Hanover, New Hampshire. Report No. CRREL-RR-320, Project DA-4-A-162121-A-89-1. 38 pp. (June, 1974).

A brief review of the literature on Cd in the environment, with emphasis on its role in soils and water, is presented. Experimentally, the interaction of cadmium with 2 soils and 1 naturally occurring zeolite was examined using Ca-saturated and K-saturated samples. The soils preferentially bound Cd in the presence of either Ca or K with decreasing Cd selectivity as the fractional Cd surface increased. Cd sorption was relatively higher with the K soils as compared with Ca soils. A method for monitoring the flow of Cd thru soil columns was examined.
Source: 4

#39
Blum, W. "Air pollution and filtering effectiveness of forests." Forester, 20(10):211-212, 214-5 (1965).

Filtering effectiveness of forest involves 1) braking effect and precipitation of pollutants, distribution effect through ad- and absorption, "hold-back" property of already deposited pollutants, 2) passive shielding effect through deflection of air currents. For best filtering, trees should be between emitters and people, 2) as close as possible to human settlement. Resistance to pollution has two components: 1) plant-specific or species-specific, 2) environmentally conditioned component determined by site. Also important is stand structure which should be open toward wind source and stratified rather than closely stacked. All these criteria differ substantially from those of a commercial forest.
Source: 6

#1982
Blum, W. "Luftverunreinigung und Filterwirksamkeit des Waldes." (Air pollution and filtering effectiveness of forests). Forst. Holzwirtschaft, 20(10):211-212, 214-215 (1965).

Criteria that determine the filtering effectiveness of forests with respect to air pollution are reviewed. The filtering effectiveness of forests consists of two components: an active filtering effect through a braking and precipitation of pollutants as a result of gravity and moment of inertia, a distribution through active adsorption, and hold-back of already deposited pollutants with respect to dispersion by wind; a passive shielding effect through deflection of air currents. The filtering action depends on many factors, including the spatial distribution of the forests, the kind and concentration of pollutants, forest structure, and meteorology. Different kinds of pollutants, their toxicity and estimated concentrations, sensitivity of various tree species to air pollutants, fundamental possibilities of appraisals for filtering effectiveness, and administrative and public aspects of forestry are reviewed.
Source: 1

#154
Bochauer, M. J. "Contamination of soil and vegetation near a zinc smelter by zinc, cadmium, copper and lead." Environmental Science & Technology, 7:131-135 (1973).

Metal oxide fumes escaping from two zinc smelters in Palmerton, Pa., have highly contaminated soil and vegetation with zinc, cadmium, copper, and lead. Within 1 km of the smelters, 135,000 parts per million (ppm) zinc, 1750 ppm cadmium, 2000 ppm copper, and 2000 ppm lead have been measured in the O_2 horizon. Approximately 90% of metals deposited on the soil surface have been retained in the top 15 cm of the soil profile. Depauperate trees within 2 km of the smelters contained up to 4500 ppm zinc and 70 ppm cadmium by weight in washed, oven-dried foliage. Metal aerosols may enter the leaves directly, presumably through open stomates.

Contamination of soil and vegetation owing primarily to airborne heavy metals occurs in urban areas (Purves and Mackenzie, 1969), along highways (Motto et al., 1970: Daines et al., 1970; Lagerwerff and Specht, 1970; Hutchinson, 1971), and near smelters and foundries (Toumey, 1921; Lundegardh, 1927; Greszta and Godzik, 1969; Costescu and Hutchinson, 1971). Soil contamination by zinc, lead, and copper aerosols has been recognized for decades, but cadmium was overlooked until recently. The first published study reporting soil contamination due to airborne cadmium is probably that of Greszta and Godzik (1969), who found high concentrations of cadmium zinc, and lead in soil near a zinc smelter in Poland.
Source: 7

#924
Boertitz, S. "Bedeutung unsichtbarer Einfluesse industrieller Immissionen auf die Vegetation." (The importance of invisible influences of industrial immissions on the vegetation). Text in German. Biol. Zentralbl., 93(3): 341-349 (1974).

The literature on the major invisible effects of industrial emissions on vegetation is reviewed. No macroscopically visible symptoms are produced in plants contaminated by gaseous and/or solid emissions if the pollutants are resorbed by the plant material and stored in the interior or adhere to the surface. Reactions in the plant material which occur only briefly due to concentration peaks in the emission area and are reversible produce neither visible signs nor structural changes within the cell. Long-term exposure to small emission concentrations might not produce any visible symptoms but can produce latent effects.
Source: 1

#925
Boertitz, S., and H.G. Daessler. "PVC-Muell als Asugangspunkt fuer Pflanzenbeschaedingungen." (PVC trash as a source of plant damage). Translated from German. Nachrichtenbl, Pflanzenschutzdienst, D.D.R., 25(2):34-36 (1971).

Various products arise from burning and smouldering material. Plants growing near trash incinerators or dumps where trash is burned may be harmed by

the toxic products which are formed, such as sulfur dioxide. Polyvinyl wastes burned in trash dumps can produce hydrogen chloride which can cause plant damage. Smoke damage from this pollutant is discussed. Hydrogen chloride from the burning of polyvinyl chloride refuse may cause leaf damage, defoliation, and yield depression of fruit trees, berry bushes, vines, vegetables, and other plants. In spite of the expected quantitative increase in the plastics refuse, the possibility of its thermal decomposition on dumps should be eliminated in order to prevent damage to the vegetation.
Source: 1

#923

Boertitz, Siegfried and Horst Ranft. "Die SO2 und HF-Empfindlichken von Flechten und Moosen." (On the susceptibility of lichens and mosses to SO2 and HF). Biol. Zestralbl., 91(5):613-623 (1972).

The assimilation of 20-25 different types of mosses and lichens exposed to sulfur dioxide and hydrogen fluoride containing gases was studied. For the assimilation measurements with the carbon dioxide URAS, the samples were put into glass cuvettes. For a study of the externally visible injuries, the sample material was exposed for 36 hours to 3.5-5.5 mg SO_2/cu m and for a period of 27 hours to 0.3-0.4 mg HF/cu m. During the four to five days of exposure the weather was cloudy with showers. The noon temperatures were between 6 and 10C. A sunny afternoon at the end of the experiments accelerated the development of visible damages. The exposure to phytotoxic substances such as SO_2 and HF does not immediately produce visible injuries. These substances gradually are retained in the plant tissue; moreover they are capable of reversibly or ineversibly influencing the photosynthesis. The assimilation intensity diminished during fumigation and gradually picked up again afterwards, provided the assimilation apparatus was not irreversibly damaged. With several lichens and mosses the visible injuries did not correspond in any way to the damages of the assimilation organism. The physiological dynamics to the occurrence of visible damage showed no fundamental differences in lichens from higher plants affected by phytotoxic substances.
Source: 1

#56

Bohn, H. "Soil absorption of air pollutants." J. Environ. Quality, 1(4): 372-376 (1972).

Soil emits some, but absorbs many, air pollutants. The net effect of the soil is to reduce air pollution by absorbing air pollutant gases and particulate matter and converting them into less harmful forms, forms unavailable to plants and nutrients. The gases emitted by soils, such as H_2S, N_2O, CH_4, and CO, are products of reactions largely outside of man's control and are natural parts of the carbon, nitrogen, and sulfur cycles.

Soils absorb organic gases faster and in greater amounts with increasing molecular weight and with increasing number of nitrogen, phosphate, oxygen, sulfur, and other functional groups in the compound. The absorption of lower-molecular weight and less substituted organic gases depends upon the buildup of an appropriate microbial population.

The absorption of inorganic air pollutants by soils is primarily by chemical and physical means. Many of the air pollutant gases oxidize after being absorbed and produce acidity which is countered by the pH-buffering capacity of the soil.

Soils are also a source and the major absorbent of siliceous particulate matter in air. Heavy metal, fluoride, and other pollutant aerosols are absorbed and rapidly rendered unavailable to plants. The extent unavailability of most absorbed elements increases with soil pH. The inactivation of heavy metals by soils is approximately Cu >Pb >Zn >Cd >Ni.
Source: 6

#412
Bohne, H. "Ameny v drajine zpusobene emitovanymi kyselinami." (Changes of the landscape caused by industrial smoke acids). TERPLAN-Statni ustav pro uzemni planovani, Ustav krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiny, Sbornik Z. Mezinarodni Konference, Prague, Czechoslovakia, p. 14-17 (September 1971).

The influence of industrial smoke emissions of sulfur dioxide, fluorine, and chlorine on landscape is examined. Sulfur dioxide emission has been estimated to cause 80% of the plant damage found near industrial surroundings according to the literature, but more recent evidence has pointed to fluorine-containing exhaust as being the main culprit of smoke damage. Two examples are presented in favor of the latter hypothesis. Fluorine containing exhausts have been found to cause damage in gladiolas, horse-chestnuts, damson plums, apricots, forest plants; leaf burning and permanent damage have been common. Plant damage has also been observed in the vicinity of chlorine-emitting facilities. Growth depression, bleached or lightened leaves, and necroses have been observed. Damage to pear leaves from chlorine appeared as ill defined, brown necroses in contrast to the sharply defined black-brown edges resulting from fluorine damage.
Source: 1

#927
Bohne, H. "Klarung eines Rauchschadensfalles bei Kiefernbestanden im Ruhrgebiet." (Explanation of a case of fume damage in scotch pine stands in the Ruhr). Mitt. Forst. Bundesvers., 97:141-150 (1972).

Sulfur dioxide emitted from coal-burning factories about 4 km to the south and southwest is responsible for the extremely poor appearance and stagnation in the diameter growth of pine stands in the center of the Ruhr. During the growing season, observations of the vegetation were made repeatedly in a wide circle around the works. These revealed trees and bushes which were completely dead or killed off on one side, asymmetrical growth of many plants, color changes in a wide range of plant species, and a progressive reduction in the frequency of these phenomena with increasing distance from the works

in all directions. The symptoms of leaf injury were characteristically more pronounced on the side nearer the works, indicating the emission of fluoride compounds from one of the factories. The results of the chemical leaf analyses for sulfur and fluorine confirmed the visual observations with regard to toxic substances and pollution source. Fluorine contents of 24 mg% in leaves and 10 to 14 mg% in the pine needles was found. Measurements of the annual rings showed that diameter increments ceased completely after 1956, which was the year when pollutants were first emitted from the production of fertilizer. The greatest portion of the damage due to acid fumes was caused by pollutants containing fluorine; by comparison the damage caused by SO2 was of lesser importance.
Source: 1

#404
Bohne, Helmut. "Kurzmitteilung: Wirkungen von Staubimmissionen auf Pflanzen." (Brief report: Effects of dust emissions on plants). Staub, Reinhaltung Luft, 33(12):489-491 (1973).

A number of examples of industrial dust emission causing a plant damage are described. A lime containing cement work dust formed a thick white crust on plant needles and leaves, preventing normal growth. Zinc and lead containing dust emitted from a zinc plant burned the leaves in an orchard two km away. Lime containing dust with an ashing loss of 50 to 60% from a soft coal processing plant reduced the yield of a nearby rye crop by 3 tons/hectare and that of a sugar beet crop by 50%. Soot, with an ashing loss of 99.9% and particle size of 15 to 100 microns, coats entire plants with a thin film, leading to their eventual decay.
Source: 1

#411
Bolay, A., E. Bovay, G. Neury, J. P. Quinche, and R. Zuber. "Degats causes aux abricots et a d autres fruits par les composes fluores." (Damage to apricots and other fruits caused by fluorine compounds). Text in French. Revue Suisse de Viticulture et Arboriculture (Lausanne), 3(3):82-92 (May-June 1971).

Stone fruits (apricots, peaches, plums and cherries) pears, and apples grown in the alpine valley (Valais, South Tirol, and Savoy) were examined for fluorine-induced damages. Climatic conditions, particularly temperature, humidity, and precipitation, were observed and correlated. Symptoms of fluorosis on the stone fruits were characterized by well-delimited brown-black necroses, sometimes sourrounded by a reddish aureole. The necroses were deep and reached to the stone on very young fruits and were rather superficial on fruits approaching maturity, which were most sensitive to fluorine. Pears gave similar results. Fluorosis on apples appeared as a reddening of the epidermis and rifts appearing around the apex or on the most exposed side. The apples were deformed. Damage symptoms were identical regardless of the origin of the fluorine; atmospheric pollution, fluorine salts sprayed on the fruit, or absorption by the roots from fertilizers containing fluoborate compounds.
Source: 1

#928
Bolay, A., E. Bovay, C. Nuery, and R. Zuber. "Interaction entre la fumure et la causticite des immissions fluorees." (Relationship between fertilization and the burning effect of factory emissions containing fluorides). Air Pollution Proc. First European Congr., Influence of Air Pollution on Plants and Animals, Wageningen, Netherlands, p. 143-160 (1968).

Studies made of the vineyards and apricot orchards in the central part of the Valais district of Switzerland, an area exposed to atmospheric pollution from aluminum foundries and fertilizer plants, show that the causticity of emitted fluorides and the fluorine content of the leaves depend closely on the kind of mineral fertilizer used on the plants. Just how this interaction works is still not known but three possible hypotheses are possible to explain the interrelationship; presence of chlorides, presence of boron and, finally, an unidentified substance, particular to certain phosphopotassium fertilizers. The effect of the fluoride pollution is made significantly worse by the almost linear diffusion created by the winds of this alpine valley.
Source: 1

#312
Bolay, A., E. Bovay, J.P. Quinche, and R. Zuber. "Teneurs en fluor et en bore des feuilles et des fruits d arbres fruitiers et de vignes, fumes avec certains engrais composes, boriques fluores." (Amounts of fluorine and boron in the leaves and fruits of fruit trees and vineyards, fertilized by certain boron- and fluorine-containing fertilizers). Revue Suiss de Viticulture et Arboriculture (Lausanne), 3(3):54-61 (May-June 1971).

Various orchards and vineyards were examined for absorption of fluorine and boron from the atmosphere and certain fertilizers by the fruits and leaves. Apricot trees grown in the orchards of Rechy were affected by fluorine emissions from certain aluminum factories. The amount of fluorine in the leaves was proportional to the age, regardless of the fertilizer. Young leaves, that emerged in the hot summer months, were most damaged by the fluorine emissions but contained the least fluorine. Conversely, the youngest leaves were richest in boron content. Apricot orchards in Bieudron and Fey, areas of minimal air pollution, had very few appearances of necroses. The fluorine content in the leaves remained in the range of 17-28 ppm. A stronger application of fertilizer increased the fluorine content but had no notable effect on the boron content or chemical composition of the apricots. Comparable results were gathered in one of the apricot orchards in Martigny. The other, exposed to fluorine emitted by an aluminum factory, had a higher fluorine content in the leaves. The treatment of apricot trees by a fungicide containing fluorine had no effect on the fluorine content. The boron content was clearly increased upon application of the boron-containing fertilizer, but the fruits did not absorb the fluorine of the fertilizer. Tests on orchards in Marcelin and Changins, areas virtually free of fluorine in the atmosphere, determined an increase in fluorine content in the leaves and of necroses due to the fertilizer. Plum and pear trees examined under similar conditions gave comparable results, with slight variations for different variables of pollution and fertilizer. Vineyards were also tested in Valais. General results indicated that the combined boron-containing fertilizers determined an evident accumulation of fluorine in the leaves of the plants but had no effect on the fluorine content in the fruits, which was proportional to the degree of pollution by industrial fluorine emissions in the atmosphere.
Source: 1

#909
Bolter, E., D. Hemphill, B. Wixson, D. Butherus, and R. Chen. "Geochemical and vegetation studies of trace substances from lead smelting." Missouri Univ., Columbia, Environmental Trace Substances Center and Extension Div., Trace Subst. Environ. Health, Proc. Univ. Mo. Annu. Conf., 6th, Columbia Mo., p. 79-85 (June 13-15 1972).

Several hundred soil and vegetation samples from the Viburnum Trend or New Lead Belt of Southeastern Missouri were analyzed for lead, zinc, copper, cadmium, manganese, and total sulfur to determine natural background concentrations and to delineate areas of anomalous high concentrations caused by the mining and lead smelting activity. The area around one lead smelter showed anomalous high heavy metal concentrations for a distance of several miles. Other activities, such as the transport of ore concentrate in open trucks or by railroad, also act as sources of pollution. Elevated heavy metal concentrations in soils were mainly restricted to the humus layer on the surface of the soil and to the top 1-inch soil layer. Most of the leaf found in vegetation samples was present on the surface of the leaves. Source: 1

#1584
Bonte, J., and L. DeCormis. "Effets du dioxyde de soufre sur les mouvements stomatiques des plantes." (Effects of sulfur dioxide on the stomatic motion of plants). Proc. Int. Clean Air Congr., 3rd, Duesseldorf, West Germany, p. A134 - A138 (1973).

The effects of constant sulfur dioxide concentrations ranging from 0.25 to 2 ppm on the stomatic motion of isolated Geranium leaves was studied by measuring the rate of stomata opening by the hydrogen diffusion method in a porometer. The leaves were exposed to SO_2 between 11 am and 6 am at a carbon dioxide concentration of 300 ppm and a light intensity of 6000 lux, the relative humidity and temperature being 75% and 26 C, respectively. Defense mechanisms against SO_2 are observed. Immediate decrease in the area of the stomata opening, preceded by short-term increase, was observed. Relationship between the intensity of defense reaction and the SO_2 concentration was observed. Necrosis due to SO_2 concentrations of 0.5 ppm and over was noted. Source: 1

#911
Boray, E. "Les emissions fluorees industrielles: leurs effets sur les plantes et les animaux." (Industrial fluorine emissions: their effects on plants and animals). Proc. Int. Congr. Pro Aqua-Pro Vita, Basel, Switzerland, 163-184 (1972).

Emissions of fluorine compounds from metallurgical and chemical factories, particularly aluminum factories and phosphate fertilizer plants, are a source of pollution of a high grade of cauticity with regard to vegetables, for very weak fluorine concentrations in the air, in the range of 1 microgram hydrogen fluoride/cu m of air. Some plants are even more sensitive to the effects of fluorine compounds, like apricot trees, vines, barberry, gladioli, the Liliaceous species in general, pine trees, Norway spruce, and other forest trees. These sensitive species form typical necroses on the

edge or at the tip of the leaves for fluorine contents in the dry matter lower than 50 mg/kg. The topographic situation of the factories plays an important part in the diffusion of gases. Fluorine intoxication (fluorosis) of animals originates most frequently from the absorption of fluorine compounds in fodder which originate from volatile F compounds issued by certain metallurgical and chemical factories. The symptoms of fluorosis include mottling and wearing of teeth, osteofluorosis, high fluorine content of bones and urine, and secondary effects like limeness and reduced milk production. The fluorine content of the total daily diet of milk cows should not exceed 30 mg/kg dry matter. Factories emitting F have generally taken precautions to reduce these emissions to 10-15%; however, a larger reduction must be reached in areas with highly F-sensitive plants.
Source: 1

#117
Bormann, F. H., P. R. Shafer, and D. Mulcahy. "Fallout on the vegetation of New England during the 1957 atom bomb test series." Ecology, 39:376-378 (1958).

Attempted to determine the source as well as the local and regional distribution of radioactive fallout in order to describe conditions that should be taken into consideration by those doing isotopic experiments. Also hoped to see what ecological relationships controlling distribution of fallout were. Externally deposited fallout seemed to be the most important.
Source: 7

#962
Bortitz, S. "Physiologische und biochemische Beitrage zur Rauchschadenforschung. II. Mitteilung: Analysen einiger Nadelinhaltsstoffe and Fichten unterschiedlicher individueller Rauchharte aus einem Schadgebiet." (Physiological and biochemical contributions to the research of flue gas damage. Report II: Analyses of some contents of spruce needles having different individual flue-gas hardness originating from a damage zone). Translated from German. Arch. Fortswes, 18: 123-131 (1969).

Spruce needles from a mountainous area were examined after continual subjection to short periods of relatively high levels of atmospheric sulfur dioxide contamination. The metabolism of plants damaged to different degrees by flue gases was investigated to determine reasons for resistance based on internal structure. Paper chromatography was used for carbohydrate analysis and tannin content determined by titration with potassium permanganate. pH analyses were made using methods previously developed for needle analaysis. The first sign of SO_2 damage is a foster aging of the needles of less resistant trees. Surprisingly, the level of active photosynthesis did not decrease significantly in the damaged needles, but the faster aging process and resulting net loss of needles reduced the total tree activity and material storage. In contrast to needles of resistant trees, those of damaged spruces have a lower water content, a higher sugar level, a lower acidic buffer capacity, and a higher pH in their cell sap. This last finding is unexpected in light of the acidic nature of flue gas. The degree of these effects shows a dependence upon the time of year. Comparisons with other studies shows an apparent influence on the type of SO_2 damage of the degree and length of exposure to the pollutant flue gas.
Source: 1

#759

Börtitz, S. and M. Vogl. "Zur Transfuration von Koniferennadeln bei Untersohiedlieher SO2 Finwirkung." (On the transpiration of conifer needles with differing exposures to SO2). Arch. Forstwes, 11:663-? (1967).

The using of conifer needles from smoke-damaged trees with high sulfur dioxide concentrations (10-200 ppm) produced a decrease in assimilation and an increase in transpiration that was followed by a subsequent decrease as cell destruction in assimilation organs progressed. Gassing with low SO2 concentrations produced two completely different reactions. In one sample, a clear decrease in assimilation was observed following exposure of needles to 1.7 ppm SO2, but further gassing with carbon dioxide balance was required to increase transpiration. In another case, 0.85 ppm SO2 produced a simultaneous lessening of assimilation and transpiration. In field measurements, a decrease in transpiration was observed only where a decline in assimilation was already apparent. These results are compared with earlier, contradictory studies.
Source: 1

#410

Bossavy, J. "Action des fluorures gazeux sur les especes forestieres." (The action of gaseous fluorine compounds on forest species). Itern. Clean Air Congr. Proc., London, England, Paper VI/13. 193-196 (Oct 4-7, 1966).

Fluorine pollution-induced damage on woody species and measures to be taken to prevent such damage are reviewed. In leaf-bearing trees, fluorine migrates to the boundary portions of the leaf and produces tip or marginal necrosis as soon as the toxicity threshold is reached. Leaf necrosis is produced in certain species by 0.025 ppm fluorine concentrations in the air. Continuous accumulation if fluorine contents by coniferous species is illustrated by data accumulated during 1963-1965 in France. Thus, one year old needles had 277 mg fluorine/kg dry matter at 900 m altitude, 138 at 1300 m altitude, and 47 at 1520 m altitude; two year-old needles had 635, 200 and 85 mg fluorine/kg dry matter at the corresponding forest sampling points located six to ten km distance from the polluting source. Leaf-bearing trees show a tendency to accumulate fluorine within the same season to a higher extent than the coniferous species. Thus, beech tree leaves may accumulate up to 970 mg fluorine/kg, maple leaves may accumulate up to 675 mg/kg, and oak leaves may gather up to 421 mg fluorine/kg within one season. Despite such elevated concentrations, premature leaf fall seldom occurs. Apparently, the annual leaf fall prevents the accumulation processes occurring in the coniferous species. Long therm effects of fluorine pollution lead to soil alterations which may hamper large forest areas. Accumulation of fluorine bearing dust particles on the ground surface and their further infiltration by rain and snow waters may produce chemical alterations of the superficial soil layer. These alterations include increased acidity which modifies the bacterial flora and produces impairment of calcium and nitrogen mobilization within the vital soil layer. Soil treatment with appropriate salt or alkaline additives as well as continuous fertilizer treatment to increase plant resistance against air pollutants are considered among the essential measures to be taken to prevent these damaging effects. Experimental studies show only partial benefits, limited mainly to young populations, from the application of such procedures. References are made to new protective procedures adapted in the USA and Germany, which promise new prospectives for the future.
Source: 1

#763

Bossavy, M.J. "Les necroses due au fluor." (Necrosis caused by fluorine). Translated from French. Belov and Associates, Denver, Colo., 9 p., Sept. 4, 1970. Pollut. Atmos., (Paris), 8(30):176-184 (June 1966). (Also: Revue Forestiere, No. 12, December 1965).

The shape, color and evolution of necrosis due to fluorine are described for a certain number of leaf-bearing coniferous vegetation according to the stage of development of the leaf. The experiments of Professor Holland, 1908-1909, and his album containing pen sketches and a collection of samples are presented. The only common characteristic to note is that such flaws begin to be seen at the tips of the needles; in the leaves, they will be noticed either at the very tip of the leaves, in long narrow leaves, or else almost simultaneously at the tip and on the edge of the leaf if such is a wide and whole leaf. If the leaf has serrated edges, the necrosis is evident at the points of tips of the lobes. Often the tainted parts assume a "V" shape, the point directed towards the leaf stalk, but it quickly moves along the leaf blade and assumes a very different shape. In the cherry and other plants, the tainted parts will be easily detachable, leaving an undulating line where they have been severed. Little patches of yellowish color will often be dispersed along the lade and inside the leaf itself. The color of the damaged parts varies from black to a brown or ruse color. Sometimes all needles of the same age on a given branch will show necrosis of the same color obviously in the same stage of development. Characteristics are cited for the cherry tree, chestnut, alfalfa, walnut, peach, pear, sainfoin, vine, lime tree, larch, hawthorn, saffron, barberry, gentian, millepertuis, myrtle, lily of the valley, solomon's seal, silene, the common pine, pectin fir, and spruce. Meteorological factors are also mentioned.
Source: 1

#764

Bossavy, J. "Informations sur les dommages causes par la pollution de Mair aux plantes et aux animaux dans les pays europeens." (Information on damage caused by air pollution to the plants and animals in European countries). Translated from French. Belov and Associates, Denver, Colo., Sept. 3, 1970. Air Pollution Proc. 1st European Congr. on the Influence of Air Pollution on Plants and Animals, Wageningen, The Netherlands, p. 15-26 (1968).

All specialists agree that sulfur dioxide and fluorine compounds are particularly important plant toxins. Picea abies, Abies alba, and Pinus sylvestris, by far the most important trees cultivated in Central Europe, are highly susceptible to these two pollutants. The damage caused by them reaches alarming proportions, endangering the existence of forests in many areas. The total area of damaged forests probably approaches 400,000 hectares. Damages to land under cultivation are less spectacular because growing conditions can be artificially improved. Pollution effects are often limited to the yield or partial loss of quality for one growing season. The influence of fluorine on animal teeth and bones is well known; the effects can be partly averted by adding correct amounts of phosphate and calcium to animal rations or by supplying feed containing sufficient minerals. In general, researeh on the effect of pollutants on vegetation is directed toward the absorption of pollutants, their transport in leaf parenchyms, and their effects on physiological processes. Creation of new species or varieties of domestic plants capable of supporting high pollution levels seems possible.
Source: 1

#1289
Botkin, D. B. "Natural ecosystems and the industrial production of carbon dioxide." In: Mineral Resources and the Environment. Appendix to Section III. Report of Panel on the Implications of Mineral Production for Health and the Environment. National Academy of Sciences. Washington. D. C.. Committee on Mineral Resources and the Environment, Department of the Interior and National Science Foundation Contract SO122128, D73, 123C, C310-285-000, p. D.1-D.24 (February 1975) NTIS: PB 239582.

The effect of carbon dioxide on the earth's biota is discussed. Little data regarding the actual net removal of CO_2 from the atmosphere by land biota exists, although it is estimated that the minimum combined effects of the land biota and the oceans result in the removal of about 49% of the anthropogenic CO_2 emitted to the atmosphere. Simulation experiments suggest that if the fertilization effect of an increase in CO_2 concentration is uniform across different tree species in a forested area, then changes in the biomass of a forest are not likely to be observed unless the CO_2 increase is sufficient to fertilize the annual growth of each tree approximately 50% above normal. Regarding fresh water ecosystems, the rate of photosynthesis of algal communities may be limited by the rate of CO_2 movement into the lake from the air above when the total dissolved inorganic carbon in a lake is low. In general, the biota of the earth may be potentially a major sink for the CO_2 added to the atmosphere by man's activities, and added CO_2 may exert a significant effect on the production and standing crop of biota.
Source: 1

#409
Botkin, D.B., W.H. Smith and R.W. Carlson. "Ozone suppression of white pine net photosynthesis." J. Air Pollution Control Assoc., 2(12):778-780 (Dec. 1971).

The effect of ozone on photosynthesis in eastern white pine saplings in growth chambers was studied by infrared gas analysis of needle carbon dioxide exchange. Branches exposed to 50-80 pphm ozone for four hours and 80-90 pphm O3 for three hours appeared to have suppressed net photosynthesis without visible injury. Actual suppression was questionable in view of diurnal variations in net photosynthesis. Photosynthetic rates of treated branches returned to normal levels following this initial exposure. Subsequent exposure to 90-100 pphm of O3 for three and five hours reduced net photosynthesis approximately 80% and significantly altered diurnal patterns. Visible symptoms appeared following this final ozonation.
Source: 1

#1944
Bouldin, D.R., R.L. Johnson, C. Burda and Chun-Wei Koo. "Losses of inorganic nitrogen from aquatic systems." J. Environ. Qual., 3(2):107-114 (1974).

Additions of NH_4NO_3 were made to 6 ponds near Ithaca, New York, and the loss of NH_4 and NO_3 from solution was followed over a 2 month period with the objective of investigating the mechanisms and magnitude of losses of inorganic nitrogen. In the ponds which were used, biological immobilization of nitrogen was small in relation to the total amount added. Losses of NH_4 ranged from 2 to 38% per day in different ponds. An NH_3 volatilization model based on concentration of ammonium N and water pH was consistent with the experimental data, and the results were in agreement with the hypothesis that the major avenue of NH_4 loss was by NH_3 volatilization across the air-water interface. Nitrate losses ranged from 7 to 15% per day in the different ponds. The results were consistent with the hypothesis that nitrate loss was primarily by denitrification in the bottom sediments. Models for loss of both ions were derived which have general application to other bodies of water. Although the experimental data were obtained in ponds which are not necessarily typical of other bodies of water, the models are based on general chemical and physical parameters which are not peculiar to the ponds studied (that is, depth of water, water pH, and a reduced zone of sediments underlying a thin oxidized layer of sediment). The results suggest that NH_3 volatilization and denitrification are mechanisms which may account for appreciable losses of N from many bodies of water.
Source: 5

#910
Boussingault, M. "Sur l'action deletere que la vapeur emanant du mercure exerce sur les plantes." (Plant physiology on the deleterious action that the vapor emanating from mercury exercies on plants). Translated from French, Belov and Associates, Colo., 9 p., March 12, 1970. Compt. Rend., 64:924-92 (1867).

The effects of mercury vapor on plants were investigated. When a mercury filled capsule was placed on each side of a petunia stem, the leaves turned black, withered, and were hanging. Another petunia, enclosed under a dish-cover where there was no mercury, retained all its vigor. Experiments were also conducted on mint plants. On the inner surface of one dish-cover sulfur was placed on the flower. In the other dish-cover there was no sulfur. In less than 52 hours, the mint leaves in the dish containing only mercury had been completely destroyed. The leaves of the plant in the dish also containing sulfur were not affected. It was concluded that mercury vapor has a damaging effect on vegetation, and that the presence of sulfur counteracts this effect.
Source: 1

#765
Bovay, E. "Effets de l'anhydride sulfureux et des composes fluores sur la vegetation." (Effects of sulfur dioxide and fluorine compounds on vegetation). Air Pollution Proceedings of the First European Congress on the Influence of Air Pollution on Plants and Animals, Wageningen, Netherlands, 111-135 (1968).

The sources of sulfur dioxide and fluorine pollutants are described, and the damage caused to plants by these compounds are related. Sulfur dioxide penetrates to the interior of plants through the stoma; therefore every condition favoring the opening of the stoma also increases the assimilation of SO_2. The caustic action of SO_2 is due to its reducing action, which can affect plant metabolism. Sensitivity to SO_2 depends on such factors as age, nutritive state, and individual tolerances. Relationships between pollutant concentration and time of exposure are a determining factor in threshold limitations. A distinction between plant injury and damage is made. Various attempts to observe and control atmospheric pollution are described. Fluorine compounds are among the most toxic of pollutants. Fluorine accumulation in soils and plants is discussed. The effects of fluorine on various types of plants are noted. Synergistic action can occur when certain elements introduced by fertilizers react with fluorine compounds found in the atmosphere. Most plants seem to have a fluorine threshold beyond which photosynthetic processes can be invisibly damaged. Certain plants, due to their highly sensitive nature, can act as indicators of atmospheric pollution. Recent experiments involving the effects of fluorine on fruit trees are described.
Source: 1

#930
Bovay , E. "Effets de la pollution de l'air sur les plantes." (The effects of air pollution on plants). Text in French. In: Probleme der Luftverrunreinigung durch die Industrie, Switzerland. Vogt-Schild S. A., p. 1-19 (1969).

A review is presented of sources of SO_2, methods of measuring it in the atmosphere, maximal permissible SO_2 levels, its mode of action on plant tissues, contributory factors, sensitivity of species and plant organs and methods of evaluating damage caused by SO_2, including inspection, air analysis, analysis of the affected tissues, microscopic examination, and turbidimetric tests. Some of the same subjects are also discussed for fluorine emissions. Damage from these and other pollutants, including chlorine, hydrogen sulfide, zinc oxide dust, dust from cement plants, compounds of arsenic and molybdene, coal tar fumes, automobile emissions, ozone, peroxyacetyl nitrate, and smog, to a variety of plants is described.
Source: 1

#929
Bovay, E., A. Bolay, R. Zuber, P. Desbaumes, G. Collet, J. P. Quinche, G. Neury, and B. Jacot. "Influence de certains engrais combines boriques sur l'accumulation du fluor dans les vegetaux." [The effect of certain combined boron fertilizers on the accumulation of fluorine in vegetables]. Revue Suisse de Viticulture et Arboriculture (Lausanne), 1(2):30-33 (March-April 1969).

Tests with grapevines, apricot trees, and forage plants performed on field lots, in potted plants, and in the laboratory disclosed that the use of certain combined fertilizers resulted in an accumulation of fluorine in the plant tissues, particularly in leaves. The fertilizers in question were manufactured by direct solubilization in a strong acid of a mixture of crude phosphates, of a potassium salt, and of a boron compound. An analysis of three different types of these fertilizers disclosed the presence of potassium fluoborate which as a result of its solubility is absorbed by the plant roots and accumulates in plant tissues. This accumulation was greatest at elevated temperatures, under strong illumination, and at low relative humidity and drought conditions, probably as a result of accelerated evapotranspiration. The manufacturers of the fertilizers in question were advised of these findings and the objectionable method of manufacture discontinued.
Source: 1

#418
Bovay, E., and R. Zuber. "Necroses sur abricots: essais de gazage au moyen d acide fluorhydrique " (Necroses on apricots: gasing experiments with hydro fluoric acid). Text in French. Revue Suisse de Viticulture et Arboriculture (Lausanne), 3(3):78-81 (May-June 1971).

Necroses on apricots were frequently observed in the alpine valleys where certain chemical and metallurgical industries, particularly aluminum factories, were emitting fluorine into the atmosphere. Gasing experiments were conducted with various concentrations of hydrofluoric acid on apricot trees and picked fruits. Meteorological conditions of temperature, humidity, and precipitation were observed. Exposure to hydrofluoric acid caused necroses to appear on the leaves and the apricots similar to the necroses on the fruits affected by industrial fluorine emissions. A dry climate, high temperature, fine precipitation followed by long periods of sunny weather, followed in turn by more dry spells were favorably correlated to the appearance of necroses.
Source: 1

#74
Bowne, N. E. "Diffusion Rates." Publ. by The Research Corporation of New England, Wethersfield, Connecticut. This paper presented as Paper 73-130 at the 66th Annual Meeting of the Air Pollution Control Association (1973).

The Gaussian diffusion model has achieved considerable popularity among people attempting to describe the role of atmospheric dispersion. The ease of application of this model for conservative pollutants outweighs its shortcomings as a complete mathematical description of the diffusion process. Most engineers employing the model have used the classical dispersion rates origi-

nally designated by Pasquill and Gifford. Turner's Workbook has provided additional impetus to use of this model, often by engineers not familiar with either the mathematics of the model or the experimental data used to determine the dispersion rates. The purpose of this paper is to provide a set of three families of dispersion curves, based on experimental data gathered since 1963, to yield dispersion rates appropriate to urban and suburban areas, as well as the rural areas appropriate to the Pasquill and Gifford curves. McElroy and Pooler's curves for urban rates are extended to shorter distances and a set of curves appropriate to suburban areas of heterogeneous topography are proposed.
Source: 8

#1966
Boyer, J., and M. Bousquet. "Les nuisances II. La penurie d espaces verts." (Pollutants II. The scarcity of green belts). Concours Med. (Paris), 93(12):2089-90, 2093, 2095-2096 (Nov. 20, 1971).

The role of green belts as islands of relatively clean air has been demonstrated by their ability to remove from the atmosphere part of the dust pollution and to absorb a certain amount of sulfur dioxide, especially in summer. While London and Rome have nine sq m green space per inhabitant, Berlin 13 sq m, and Vienna 25 sq m, Paris has only one sq m green space for inhabitant. While fortifications in Paris quite recently could have been replaced by a circular green belt, apartment houses were erected instead. Another chance was missed when the slaugher-house in Villette was rebuilt on a site which could have been converted to a green belt. Many other occasions have been missed either for lack of funds or because of conflict with commercial interests. Also, suburban communities have, for the most part, not made adequate provisions for the establishment of green belts and are not much better off in this respect than Paris proper. Only Vanves has an 11 hectar park and numerous green squares, thanks to a hygienically-minded mayor. Elsewhere existing green spaces are progressively being eliminated. Thus, the last century has seen a 1000 ha decrease in the area of the woods of St. Germain and a 2000 ha decrease in the area of the woods at Bondy. Highway construction is the largest contributory factor in the disappearance of green belts in Paris.
Source: 1

#912
Bradshaw, A. D. "The ecological effects of pollutants." Inst. of Fuel, London, (England), Fuel Environ. Proc. Conf., Eastbourne, England, (Nov. 26-29, Paper 10, 1973) p. 129-134.

The ecological effects of coal mining on the land and airborne sulfur dioxide emission on vegetation are considered in connection with the British fuel industry. Sulfur dioxide emissions are a problem in terms of short range transport of SO2 and long range transport sulfates resulting from the oxidation of SO2. Major plant damage occurs when SO2 concentrations reach about 400 micrograms/cu m, though there is increasing evidence that low levels of SO2 can cause reductions in growth without visual symptoms. Sulfate deposition usually occurs either as a sulfuric acid or as ammonium sulfate, with either form adding to the acidity of soil and causing in high enough concentrations the leaching of calcium from the soil.
Source: 1

#931
Brandt, C. J., and R. W. Rhoades. "Effects of Limestone dust accumulation on composition of a forest community." Environ. Pollut., 3:217-225 (July 1972).

Two sites in southwestern Virginia were sampled to determine the effects of dust accumulation on structure and composition of a forest community. Compared with the control site, signficant changes in structure and composition had occurred in the seedling shrub and sapling strata of the experimental site, which had heavy accumulations of dust from limestone processing plants. Dominance in the tree stratum was also changing. Leading dominants in the control site were Quercus prinus, Q. rubra, and Acer rubrum, whereas those in the dusty site were Quercus alba, Q. rubra, and Liriodendron tulipifera. Species expected to assume ultimate dominance in the experimental site, if dust accumulation continues, are L. tulipifera, Acer saccharum, and possibly, Quercus muehlenbergii.
Source: 1

#913
Brandt, C. J., and R. W. Rhoades. "Effects of limestone dust accumulation on lateral growth of forest trees." Environ. Pollut., 4(3):207-213 (April 1973).

The annual ring measurements of four species of trees in two areas were studied to determine the effects of limestone dust on lateral growth of forest trees. The control site had essentially no dust accumulation, while the test site had heavy dust accumulation from nearby limestone processing plants. The lateral growth of Acer rubrum, Quercus prinus, and Q. rubra decreased by at least 18% with dust accumulation; the lateral growth of Liriodendron tulipifera, however, increased by 76%.
Source: 1

#167
Brandt, C. S. "Special jubileee symposium: air pollution with relation to agronomi crops." (Presented at the American Society of Agronomy, 50th Anniversary Meeting, Atlanta, Georgia, November 20, 1957). Agron. J., 56:544 (1958).

That agriculture may be adversely affected by local air pollution generally recognized and accepted, M. D. Thomas has presented a paper at the special jubilee symposium on what has been done, while the other six papers indicate the spectrum of work being done. Two papers present different approaches to the potentialities and problems of using vegetation as an index of air pollution and indicator of pollutant dispersion. The problem of 'hidden injury' is supported in the case of smog on citrus and denied in the case of fluorides on tomatoes. Fluoride uptake from soils and its relation to air pollution with fluorides is discussed. In another paper, a new disease of grapes is described and attributed to air pollution.
Source: 1

#313
Brandt, C.S. "Discussion. Sources of lead in perennial ryegrass and radishes." Environ. Sci. Technol., 4(3):224 (March 1970).

Previously reported experiments on the sources of lead in ryegrass and radishes were discussed. Atmospheric lead contributes to the lead content of leaves, but other sources make a significant contribution. Actually, one-fourth of the filtered vs. unfiltered air data indicated that atmospheric lead is not a contributor to vegetation lead. Intuition and limited data implicated the soil as the other source. The possibility of significant variation in lead content of vegetation caused by variation in the lead content of soil was not dismissed. Statistical treatment of the data was criticized. Combination of all the data was questioned. It was indicated that a foliar spray of water, containing considerable lead, did not increase the lead content of leaves. This raised an interesting question as to how atmospheric lead does increase the lead content of leaves. Although a soluble lead compound, sprayed on a plant, did not enter the leaf, a supposedly insoluble particulate readily entered the leaf.
Source: 1

#314
Brandt, C. Stafford. "Ambient air quality cirteria for hydrofluorine and fluorides." VDI (Ver. Duet. Ing.) Ber., 164:23-31 (1971).

Air quality criteria (or standards) for fluorine are determined by fluorine s effects on vegetation, animals including man, and physical property. Fluorine s effects on vegetation are the most serious. The uptake of fluorine by plants can result in excess fluorine intake by animals, and cattle are the most sensitive animals. Cattle can tolerate up to 100 ppm of fluorine for up to 30 days. Responses are reduced feed intake, changes in dentition, and fluorine build-up in the skeleton. Knowledge of dietary limits in vegetation is less precise than in the case of animals. Fluorine can cause visible injury and growth effects. Different species have different sensitivities, but generally sensitivity depends on the amount of fluorine content in the tissue. Highly sensitive plants develop symptoms of injury when the tissue level of fluorine is less than 50 ppm. Sensitive plants show injury when fluorine content is 50 to 200 ppm, while tolerant varieties show no symptoms of injury until fluorine exceeds 200 ppm. The relationship between air pollution and fluorine in the soil is debateable, however some correlation exists for the following dose-rate relation: increase in fluoride content of vegetation over normal values experssed in ppm (delta F) equals an atmospheric concentration constant (K) times the average concentration of gaseous fluoride in the atmosphere (C) times exposure time in days (T). Vegetation analysis is difficult to translate back to an emission rate of a source. Criteria based on vegetation levels are most useful in defining a goal for an area and confirming that control is or is not adequate.
Source: 1

#521
Braun, G. "Immissionen - Der Wald als Indikator und Schutzvegetation." (Air pollution - forests as indicators and protectors of vegetation). Forstwiss. Centralblatt, 93(2):91-98 (1974).

Forest trees, especially Norway Spruce and Scotch Pine, are useful as biological indicators of air pollution since they react quickly with distinctly visible injuries (needle necrosis and loss) and diminished growth. Because of the accumulation of damaging substances in needles a chemical needle analysis can also be used for indicating air pollution. Because of their filtering effect and effect on air turbulence forests provide a defense against dust and gases. The rate of these effects is dependent on the structure of the forests.
Source: 1

#547
Braun, G. "Zur Verwendung von Tabakpflanzen als Bioindikatoren waldschadlicher photochemischer Immissionen." (The use of tobacco plants as biological indicators of photochemical air pollution affecting forest trees). Forstwiss. Centralbl., 93(4):221-230 (Aug 1974).

In two Bavarian forest close to oil industries certain tobacco cultivars were exposed between May and October 1973 in order to test and proof photochemical air pollution. Especially in one of the areas, distinct damage markings on the leaves were visible, in agreement to those described by literature as typical symptoms of smog damage. The intensity of damages was not only different between the cultivars, but also especially significant higher on the plants exposed in the neighbourhood of industry than on those exposed in a more distant area. On the other hand it cannot be excluded, that the pattern of damage was a symptom of virus infection supported by the influence of air pollution. It is referred to the problematic use of tobacco plants as biologic indicators of air pollution, and in this connection it is further mentioned the great importance of our indigenous conifers Picea abies and Pinus silvestris. For completion and better interpretation the experiment shall be repeated in summer 1974.
Source: 2

#914
Bravo A. H. "The use of color infrared photography in the detection of non-visible injury to vegetation by ozone." Clean Air Society of Australia and New Zealand, Proc. Int. Clean Air Conf., Melbourne, Australia, p. 268-273 (May 15-18, 1972).

Ektachrome Infrared film and regular color film were used to detect non-visible injury from ozone to Bel-W tobacco, soybeans, and oats. Close-up photographs using adequate filters were taken under normal sunlight conditions and with an artificial light source during specific periods of time following fumigation with low levels of ozone for up to 3 hr. Visual inspection and ordinary color photographs of tobacco and soybean 3 hr after exposure to 60 pphm ozone for 2 hr showed no injury. Infrared films, however, indicated loss of reflectance due to injured cells. Injury to oats exposed to 10 or 30 pphm

ozone was clearly visible on infrared color fil 48 hr before visual injury was present. Infrared photographs 6 hr following fumigation of oats with 30 pphm ozone for 1 1/2 hr showed a distinctive color difference at the tip of the blade and the apex of the bend as compared with control oats. Necrosis was apparent after 20 hr. Six hours following fumigation with 10 pphm ozone for 1 1/2 hrs oats showed a change in color at the apex of the bend progressing toward the tip. With soybeans, infrared color film showed no distinctive color differences prior to detectable visible injury. This was attributed to the presence in the soybean of a palisade layer of cells which prevented immediate ozone attack on highly reflective mesophyll cells. Infrared color photography can be an indicator of nonvisible injury in oats and other which may result in reduced yields and growth.
Source: 1

#766
Bredemann, C. and H. Radeloff. "Ueber Schadigung von Pflanzen durch Ammoniakgase und ihren Hachweis." (On the damage to plants by ammonia gases and their identification). Z. Pflanzenkrankh. Pflanzenschultz, 42:457-465 (1932).

Studies were conducted to compare the effects of exposure to ammonia on potted trees, potted flowers, and full-grown tomatoes kept in the light with the effects observed on the same plants kept in the dark. Trees kept in the dark and exposed for two hours to approximately 1:4000 NH_3 always suffered more severe damage than trees kept in darkness. However, the difference was not as pronounced as that recorded for sulfur dioxide damage and was confined to a narrowly limited range of concentrations. Darkness did not protect trees against increased NH_3 concentrations as it does against high SO_2 concentrations. Among the six tree species tested, ash was the most susceptible to NH_3 damage and oak, maple, and sitca spruce the least susceptible. Intermediate positions were occupied by beech and rose trees. This classification of trees according to their resistance coincides with the results of tests for the effects of SO_2. As confirmed by the tests with tomatoes and flowers, NH_3 damage is characterized by the decomposition of chlorophyll and the precipitation of tannin and is thus confined to green leaves. The crown leaves of flowers and tomato blossoms were not damaged by exposure.
Source: 1

#168
Bredemann, G. and H. Radeloff. "Rauchschaden durch schwefligsaure Abgase und ihre Erkennung." (Flue-gas damage by waste gases containing sulfurous acid and its identification). Phyopathol. Z., 4(2):13, 180-194 (1933).

Most methods for identifying plant damage due to sulfur dioxide in flue gases are not sufficiently specific for SO_2. In contrast, identification of sulfite ions in leaves is unambiguous proof of the presence of SO_2-containing gases because sulfites do not occur in normal leaves that are not exposed to SO_2 vapors. Identification of the sulfites can be made by a number of qualitative or quantitative methods, such as the blue coloration of starch in a

solution of potassium iodate, attachment to formaldehyde with titration of the OH ion thus formed, distillation in iodine solution and titration with thiosulfate, and distillation in iodine solution and precipitation as barium sulfate. Good results were obtained with precipitation of barium sulfate after a preceding oxidation with bromine vapors or hydrogen peroxide. As determined by an investigation of numerous plant samples, the amount of precipitation generally parallels the degree of damage. Among plants growing near a slag burning dump, those nearest the dump had strongly discolored leaves. The SO_2 which these plants had taken up resulted in considerable precipitation with the formation of crystals. With increasing distance from the dump, the precipitation decreased and became predominantly amorphous.
Source: 1

#767
Bredemann, G., and H. Radeloff. "Fluorine absorption through the bark of shoots and its effects." Translated from German. Angew. Botan., 19:172-181 (1937).

The effects of fluorine absorption on the shoots of plants and trees are investigated. The primary goal of the research is to determine whether the fluorine compounds which penetrate the bark of the shoots in an earlier season can affect the spring growth of the plant and/or effectively disturb the identification of fluorine fume damage on spring growth. Shoots accumulate fluorine-containing waste gases more or less in their barks, as much a result of exposure in winter as in summer. They are also capable of, but seldom do, store up accumulations in the xylum in water soluble and insoluble forms. The blossoming of branches and the further development of new growth are not noticeably injured by the fluorine compounds which are stored in the bark. All new outgrowths of fluorine-containing branches remain free of fluorine in a fume-free atmosphere. Proven fluorine content in spring growth is regularly a proof of a new fluorine fume effect during or after the blossoming.
Source: 1

#1618
Brennan, E., and P. M. Halisky. "Response of turfgrass cultivars to ozone and sulfur dioxide in the atmosphere." Phytopathology, 60:1544-1546 (November 1970).

Turfgrasses representing several genera and species were exposed for 6 hr to an atmosphere containing ozone (0.23-0.30 ppm) or sulfur dioxide (0.75-1.80 ppm). Response to either pollutant varied with the grass fumigated. Generally, bent grass and annual bluegrass were most sensitive to O_3; Bermuda grass and zoysia were most resistant; and perennial ryegrass, Kentucky bluegrass, and red fescue were intermediate in their response. Symptoms of O_3 toxicity were, typically, bleaching and necrosis of the leaf blade, except for pigmented stipples in red fescue. Red fescue and bent grass were most sensitive to SO_2; bluegrass and ryegrass were intermediate; and Bermuda grass and zoysia were resistant. Sulfur dioxide toxicity consistently resulted in necrosis of the terminal portion of the leaf blade.
Source: 1

#932
Brennan, E. and I.A. Leone. "The response of plants to sulfur dioxide or ozone-polluted air supplied at varying flow rates." Phytopathology, 58: 1661-1664 (Dec. 1968).

The response of tomato and cucumber plants to identical concentrations of either sulfur dioxide or ozone that was circulated over the plants at two different flow rates in paired fumigation chambers was investigated. At 0.40 ppm SO2, tomato plants were not injured in 4 hr regardless of the rate of flow. At 0.50 ppm SO2, necrosis occurred at both rates, but was more severe at the high rate of flow. At 0.65 ppm SO2 plant injury was severe at both flow rates. Exposure for 3 days at 0.30 ppm resulted in plant injury only at the high flow rate. Plants fumigated with SO2 at the high flow rate tended to accumulate a greater total and soluble sulfur content than those exposed to the same concentration at the low flow rate. In the cucumber, the high flow rate at 0.18 ppm ozone concentration caused an upper surface bleaching of both the primary and secondary leaves, whereas the low rate injured only the primary leaves. At the increased concentration of 0.22 ppm ozone, the low flow rate caused damage to both aged leaves but the high rate caused even more extensive damage. The results of exposure of the cucumber to SO2 were similar to those of the tomato plant. Similar results were also obtained from naturally occurring pollutants when ambient air was circulated over tobacco and petunia plants at the two flow rates.
Source: 1

#419
Brennan, E., and I. A. Leone. "Chrysanthemum response to sulfur dioxide and ozone." Plant Disease Reptr., 56(1):85-87 (January 1972).

Sixteen varieties of rooted chrysanthemum cuttings were exposed to concentrations of sulfur dioxide or ozone that might occur in highly polluted ambient air. None of the varieties was particularly sensitive to either SO_2 or O_3. At 4.5 ppm SO_2 for 4 hr, only five varieties were even slightly damaged; at 0.30 ppm O_3 for 3 hr, only two varieties were slightly damaged. By comparison, at these concentrations zinnia, geranium, and pinto bean would be injured by SO_2 and tobacco, tomato, pinto bean, squash and cucumber would be injured by O_3.
Source: 1

#1157
Brennan, E., I.A. Leone and R.H. Daints. "Investigation of SO2 effects on rubber trees as a means of forstalling injury to Malayan plantations from refinery emissions." J. APCA, 14:229-233 (1964).

Requested by Esso Research and Engineering Company on behalf of Esso Standard Malaya Limited, the Shell Refining Company (Federation of Malaya) Limited, and the Department of Chemistry, Ministry of the Interior, Federation of Malaya, to make a study of the effects of SO2 concentrations on

rubber trees; the Air Pollution Group of the Plant Pathology Department of Rutgers Agricultural College subjected rubber trees to short- and long-term fumigations at increasing SO2 concentrations in a test fumigation chamber. Results of the tests led to the following conclusions: (1) Four-hour fumigations of dry rubber trees under conditions simulating the climate of Malaya did not produce injury until the concentration of 0.78 SO2 ppm was reached. (2) Fifteen-minute exposures of the trees failed to cause injury until the concentration of 75 to 100 ppm SO2 was reached. (3) When rubber plants having wet leaves were fumigated for a four-hour period, slight injury was produced at 0.40 ppm SO2. (4) Total sulfur determinations of composite dry leaves showed no significant increase over that in untreated checks until the concentration of 0.70 ppm SO2 was reached. (5) Trees which were fumigated wet showed a significant increase in total sulfur content over dry check trees even at the lowest SO2 concentration of 0.13 ppm. (6) Old leaves consistently had a higher total sulfur content than did younger leaves. (7) In young leaves a considerable part of the absorbed sulfur (up to 30%) could be washed off the surface, whereas old leaves or composite samples failed to show any decrease in sulfur content on washing. This might be used as a criterion for exposure of foliage to atmospheric SO2. (8) A three week fumigation at 0.30 ppm SO2 the maximum concentration predicted by Esso engineers in the Port Dickson area, failed to produce any injury symptoms. (9)A total sulfur content of the foliage sufficient to cause injury when accumulated at a rapid rate failed to injure when accumulated over a three week period. (10) Respiration studies failed to indicate the possibility of hidden injury occurring during this prolonged fumigation. (11) Rubber trees respond similarly to other woody species to the presence of SO2 being injured at much higher concentrations than were most of the herbaceous species tested.
Source: 6

#933
Brennan, E., I. A. Leone, and P. M. Halisky. "Response of forage legumes to ozone fumigations." Phytopathology, 59:1458-1459 (October 1969).

Foliar injury was observed in Pennscott red clover(Trifolium pratense) coincident with elevated concentrations of ozones in the ambient air. To verify that ozone was the phytotoxic agent, 10 varieties of forage legume were exposed for 4 hours intervals to five ozone concentrations ranging from 0.10 to 0.30 ppm. At 0.10 ppm ozone failed to produce any visible foliar injury in any forage legume. As the ozone concentration was increased to 0.15 ppm and higher, red clover, white sweet clover, and Ladino clover were increasingly injured. Clover and alfalfa were only slightly damaged with increased ozone concentration, whereas crown vetch was uninjured even at the 0.30 ppm ozone. At the lower ozone concentrations or the day following fumigation, water soaked areas appeared on the leaves, which progressed to the necrotic state within the next two days, depending on the amount of sunshine. At the higher concentrations, water soaking was observed on the more sensitive varieties by the end of the fumigation. The high ozone sensitivity of red clover was confirmed.
Source: 1

#262
Bressan, D. J., R. A. Carr, and P. E. Wilkniss. "Geochemical aspects of inorganic aerosols near the ocean-atmosphere interface." (Presented at the American Chemical Society, Division of Water, Air, and Waste Chemistry Meeting 162nd, Washington, D. C., September 15, 1971.) Advan. Chem. Ser., 123: 17-30 (1973).

Geochemical aspects of inorganic aerosols near the ocean-atmosphere interface are discussed; and data are presented for the composition of marine aerosols with respect to geographic area, the relative chemical composition of marine aerosol salt versus altitude, and elemental ratios in aerosols. Apparently, sources contributing to the composition of inorganic aerosols near the ocean-atmosphere interface are the oceans themselves, continental dust, volcanic ash, atmospheric production of particulates, and, to a lesser extent, human activity and extraterrestrial inputs. Characteristic elements and elemental ratios can be used to determine some of these sources and detect ion fractionation at the sea-air interface. Rain water chemistry is not always simply related to that of the marine aerosol as indicated by rain particulate composition analyses performed.
Source: 1

#41
Brewer, A. W. and A. W. Wilson. "The regions of formation of atmospheric ozone." Quart. J. Roy. Meteorol. Soc., 94(401):249-265 (July 1968).

The nature and magnitude of the source of the natural ozone of the atmosphere is discussed and the results of calculations of the local rates of production in the periods January-February and July-August are given. The effect of different assumptions and models on the deduced source regions and source strengths is demonstrated. It is concluded that the most satisfactory result is obtained using solar ultraviolet intensities recently measured in the stratosphere. It is possible that there may be some catalytic destruction of ozone by water vapour, but below 35 km the effect must be small.
Source: 1

#915
Brewer, R.F., and G. Ferry. "Effects of air pollution on cotton in the San Joaquin Valley." Calif. Agr., 28(6):6-7 (June, 1974).

Cotton grown in smog-free carbon filtered greenhouses stationed at various locations in California's San Joaquin Valley, noted for its photochemical air pollution, was compared with cotton at the same locations picked from the field. The difference in favor of filtered air was about 10% at five points on the west side of the valley. Vegetative growth was apparently not influenced by the presence or absence of the photochemical oxidants removed by the carbon filters, but senescence was delayed several weeks in the fall by the removal of existing pollutants.
Source: 1

#1158
Brewer, R.F., F.H. Sutherland and F.B. Guillemet. "Sorption of fluorine by citrus foliage from equivalent solutions of HF, NaF, NH_4F and H_2SiF_6." Proc. Amer. Soc. hort.Sci., 76:215-219 (1960).

In trials at Riverside more F was absorbed by citrus leaves sprayed with NaF and HF than by those sprayed with NH_4F and H_2SiF_6. Differences in ion size rather than degree of ionization are thought likely to be the reason for this.
Source: 6

#420
Briggs, D. "Population differentiation in Marchantia polymorpha L. in various lead pollution levels." Nature (London) 238(5360):166-167 (July 21 1972).

A preliminary study of lead levels in populations of the liverwort Marchantia polymorpha L. is presented. The liverwort is relatively common in most shady streets in the center of Glasgow and Edinburgh and is also found in country districts. Eleven samples of Marchantia and the soil 1 to 2 cm beneath them were collected along a transect running north-west from central Glasgow to a point 13 km from the city. The lead content of plant digests and soil extracts was determined by atomic absorption spectrophotometry. High lead levels were found in Marchantia and in soils from the centers of Glasgow and Edinburgh, and in samples from Chatsworth, Dunoon, and Beattock which are away from large areas but near roads. There was usually a greater concentration of lead in the liverwort than in the soil, and high levels of lead in the Marchanti thalli were usually associated with high lead values in the soil. Four populations were studied to see if plants are differentially sensitive to lead in the medium. The three city clones grew equally well on lead agar and control medium, but the Milngavie plants, which grow in an area exposed to less lead contamination, grew significantly less well on lead agar in comparison with the control. It seems likely that lead tolerant genotypes have a selective advantage in city regions. Marchantia polymorpha, which contains higher lead levels than the brophytes used in previous studies, could perhaps be a valuable indicator species.
Source: 1

#289
Brinkmann, W.L.F. and U.D.M. Santos. "The emission of biogenic hydrogen sulfide from amazonian floodplain lakes." Tellus (Uppsala), 26(1-2):261-267 (1974).

The vertical and seasonal distribution of hydrogen sulfide was studied in four central Amazonian floodplain lakes from Feb. 1970 to July 1971. The emission of H2S was detected mainly during the period of falling water of the Amazon river which peaks out in September and October. Hydrogen sulfide was present even in some surface water samples (up to 0.40 mg at H2S-S/1). A part of the emitted H2S is recycled on a regional or local scale by means of biospheric trap mechanisms and eventual rainout, sustaining the tight sulfur cycle of the Amazonian tropics. A certain amount of the emitted H2S contributes to the S budget. Under cold front conditions the emitted H2S is rapidly recycled into the tropical forest stands.
Source: 1

#421
Brodo, I. M. "Lichen growth and cities: a study on Long Island, New York." Bryologist, 69:427-449 (1966).

The indirect influence of New York City's atmosphere on Long Island lichen are reported. Results of transect studies, transplant experiments, and mapping of natural distribution limits of corticolous lichens all indicate that for the most common species, the New York City influence is felt up to 40 miles from the center of Brooklyn, or just east of the Nassau County boundary. The city-effect is strong enough to kill a transplanted lichen within the four-month period between August and December. City-induced drought is regarded as acting on pollution-tolerant lichens close to a city center with air pollution acting over much greater distances in decreasing lichen diversity and cover. The most city-tolerant lichens are terrocolous and saxicolous species, fruticose lichens on Long Island are the least city-tolerant growth form.
Source: 1

#916
Brodo, I. M. "Lichens and cities." Proc. Int. Symp. Ident. Meas. Environ. Pollut., Ottawa, Ontario, p. 325-328 (1972).

Although the detrimental effect of urban atmospheres on lichen growth has been known for over 100 years, it has only been within the last 10 years that a serious effect has been made to use lichens as a means of detecting and even measuring air pollution. The development of these efforts is described with special consideration given to recent attempts to quantitize the lichen assay method. Various techniques are described and commented upon. The complicating environmental factors affecting lichen growth in cities, other than air pollution, are also discussed. These include drought, light intensity, and other microclimatic changes. Air pollution appears to be the overriding factor in the city effect, however. The relationship between sulfur dioxide levels and lichen appearance and absence (lichen deserts) is discussed. Suggestions for future approaches to studies on the relationship of lichens to cities are also given.
Source: 1

#169
Bromfield, A. R. "Absorption of atmospheric sulphur by mustard (Sinapis alba) grown in a glasshouse." J. Agr. Sci., 78:343-344 (April 1972).

An experiment to measure the gaseous sulfur absorbed by mustard was performed at Rothamsted during the summer (May-July) of 1968. The plants were grown in 15 pots of sulfur-free quartz chips and nourished with 1/5 strength Hoagland nutrient solution containing 6 ppm sulfur as sulfate with a specific activity (S.A.) of 1 microcurie/mg. A 0.2 aliquot of the ground plant material was treated with an ethanolic magnesium acetate solution, dried, ashed at 450C for 2 hr., dissolved in hydrochloric acid, and made to 25 ml with distilled water; total S in a 5 ml aliquot was determined using a Technicon Auto-Analyzer. Controls prepared from plants not receiving S-35 were used to measure background count-rates. The results showed that 1 mg S/pot had been taken from the atmosphere at 24 days and this had increased by 35.8 mg in

the next 20 days, while the total S increased from 6.2 S/pot to 74.7. Therefore, between 24 and 44 days, 52.5% of the plant S had been taken from the atmosphere. The S in the nutrient solution was probably adequate when growth was slow and plant uptake small (up to 24 days) but became inadequate for mustard when it grew faster. From the increased uptake of atmospheric S per pot between 24 and 44 days, the area occupied by a pot, and the mean S concentration in the air, a deposition rate of 18.6 times in 10 the minus 12th power g S/sq cm/sec and a vertical deposition velocity constant of 0.74 cm/sec were calculated. Compensating for some atmospheric S which must have been in roots (not harvested), the corrected velocity constant would be approximately 1.0 cm/sec, which is 4-5 times that measured for deposition on a horizontal surface. This implies that mustard grown under these conditions has a total leaf area absorbing S which is 4-5 times the area of soil on which it is grown. With the concentration of S found in the atmosphere and the same amounts available in the soil, mustard grown on 1 hectare of soil would, in 20 days, absorb 4.3 kg S.
Source: 1

#1290
Bromley, L. A., and S. M. Read. "Removal of sulfur dioxide from stack gases by sea water." In: Project Clean Air., Vol. 1 California Univ., Berkeley, Dept. of Chemical Engineering and California Univ., Berkeley, Bodea Marine Lab., California Univ., Research Proj., 5-15, 41 p. (Sept. 1, 1970).

That sulfur dioxide can be effectively scrubbed from stack gas by sea water has been conclusively demonstrated by theoretical calculations and by experimental work. The amount of sea water required for a single stage absorber operating on a typical, power plant flue gas, produced by the burning of fuel oil, is about 25 lb sea water/lb of stack gas. This is comparable with the amount of cooling water used by power companies. Based on limited experiments this will easily remove 90% of the SO_2 in a simple spray absorber and produce a brine effluent of pH near 6. Even 99% removal (or 99.9%) is easily attained with a short (5') packed column. An air spraying, bubbling or other oxygen addition will probably be required to obtain the necessary dissolved oxygen level in the effluent sea water before returning it to the ocean. All of the dissolved SO_2 will become harmless sulfate. The sulfate concentration in the sea water is increased less than 10%. This is far from saturation. The resulting sea water should have no undesirable effect on marine life. By using several counter-current absorbing stages or plates, or a packed or fluidized bed adsorption tower, the sea water required may be reduced by about a factor of 5 although the brine produced will have a pH between 2 and 3 and will require dilution or neutralization an aeration before its return to the ocean. Spraying over or bubbling air through sea water containing oyster shells or limestone would be a possible way to accomplish both neutralization and aeration. This, however, should be tested. Several authors have reported that from 1/4 to 1/2 of the oxides of nitrogen are removed from flue gas by such aqueous scrubbing. From an economic point of view the most attractive solution appears to be the combination of this method of air pollution control with the sea water pretreatment for a sea water conversion facility. The 5 to 10% reduction in the cost of converted water (from a projected large scale plant) by elimination of the usual sulfuric acid addition could be applied to the charges for pollution control and warrants further investigation. Because of the absence of SO_2 allows for the use of a cheap fuel oil in place of natural gas, any inexpensive SO_2 removal process should appear attractive to the utility companies. The use of fuel oil would also help conserve companies. The use of oil would also help conserve our more limited natural resources.
Source: 1

#548
Brown, R.T. "Furnace fuel, air pollution accumulated in snow and lichen growth on trees." Mich. Acad., 7(2):149-156 (Fall 1974).

Using accumulated snow sampled in March as the accumulator of air pollution, particulate matter, sulfates, and chlorides were determined by filtration and precipitation in 1970 and in 1973. At the snow sampling points on a steep hill, lichen cover estimates on sugar maple trees were also taken. Air pollution as measured by any of the three was inversely correlated with lichen cover on tree bark and inversely correlated with elevation since an inversion layer was often present and most of the city is in the valley. A dramatic reduction of air pollution resulted from a conversion of the University heating from coal burning furnaces to gas and oil burning furnaces. Lichens are beginning to recover as indicated by tiny lichens that have recently begun to grow.
Source: 2

#170
Broyer, T.C., C.M. Johnson and R.E. Paull. "Some aspects of lead in plant nutrition." Plant Soil, 36(2):301-313 (1972).

Accretion of lead by abscised barley roots from a lead nitrate solution was metabollically obtained, complemented by a fraction acquired physico-chemically. Added calcium supply did not significantly modify lead accretion. A ten-fold increase in supply concentration produced approximately a two-fold increase in lead accretion. During growth of bean, barley, and tomato plants in solution cultures, a substantial part of the lead supplied became associated with the roots; correspondingly little was present in the tops. A very large fraction of the lead associated with the roots of barley was readily extracted by various solvents, probably resident on the root surface or from free spaces therein; the remainder of the lead acquired may have been that sorbed within the root cells. A possible relationship of lead to phosphate accretion was not evident. There was no apparent effect of applied lead on the sorption of the other elements supplied. Plant dry weights, their top to root ratios and dry-weight percentages were constant under various lead supply concentrations in solution. Where lead supplies were advertently withheld, lead contents in plants were 5 to 25 times that which could have been expected under the solution culture conditions in a greenhouse with carbon filtered ambient air supply. Restriction of advertent lead supply caused no limitation of growth. If lead is essential to growth of these plant species, the critical concentration will probably be less than 2 to 6 ng atmos/g dry weight in plant tops.
Source: 1

#998

Brunig, E.F. "Die Sauerstofflieferung aus den Waldern der Erde und ihre Bedentung fur die Reinhaltung der Luft." (The world's oxygen production from forests and its significance for keeping the air pollution-free). Forstarchiv., 42(2):21-23 (Feb 1971).

Air-pollution has exceeded tolerance levels for the human well-being in many densely populated and industrialized areas. Locally, depressed oxygen levels have been observed.

Forests are frequently regarded as effective sources of oxygen supply in residential deficiency areas. Calculations based on the average net annual aboveground plant day matter production of the forest formations of the world, however, show that oxygen emission from forests are too small to affect the oxygen content of the atmosphere to a degree which could significantly and quickly improve man's environment. The total annual emission of oxygen from forests amounts to 55 billion tons, or 1/22000 of the oxygen content of the atmosphere. The oxygen emission of a highly productive plantation in the tropics emits about 60 tons oxygen per hectare and year, which corresponds to 1/400 of the oxygen content of the atmosphere above the stand. During the same period, as much oxygen will be consumed in decomposing organic matter. A net surplus would occur only if part of the produced dry matter is removed from the decomposition cycle.

Forests are the most efficient natural bio-element of aerodynamic roughness on the land surface. Results of investigations in the tropical rain forest indicate aerodynamic roughness lengths between 1 and 6 metres and a close interrelation between aerodynamic roughness of natural forests and site conditions. Forests increase turbulence by being an obstacle as a stand, and by having an aerodynamically very rough surface. The result isintensified mixing of air in the lowest layers of the atmosphere within and from above the canopy and in lee of stands. The intensified moving causes pollutants in the lower atmosphere to be more rapidly diluted. Increasing air-mixing is probably the most important non-productive function of forests in populated areas besides recreational services, local noise abatement and dust adsorption, and soil protection. Silvi-culture must concern itself with the development of stand structures, and of patterns of forest stand distribution and of landscapes which optimized the simultaneous processes of production and services, including aerodynamic functions, and critical areas. This will require thorough rethinking of goals and policies by the conventional silviculturist. The experience of tropical foresters with correlations between sites and stand structure in natural forests and with the possibilities and ecolocal limitations of stand structure manipulation is of great value in guiding the necessary research in temperate zones.

Source: 5

#934
Brunold, C. and K.H. Erismann. "H2S als Schwefelquelle bei Lemna minor L.: Einfluss auf das Wachstum, den Schwefelgehalt und die Sulfataufnahme." (Hydrogen sulfide as a source of sulfur in Lemna minor L.: Its influence on growth, sulfur content and sulfate uptake). Experientia, 30(5):465-467 (1974).

The effect of various concentrations of hydrogen sulfide on the growth, sulfate content, and sulfate uptake in Lemna minor L. was studied. Lemna minor was viable when cultivated in air containing 6 ppm H2S for 36 days. While this H2S concentration caused a slight decrease in the rate of photosynthesis, concentrations above 60 ppm caused a rather abrupt drop in the photosynthetic activity. Pronounced increase in the sulfate content in Lemna minor after cultivation at 6 ppm for 36 days was observed. In a short-term experiment, 18 ppm H2S caused rapid decrease in the sulfate uptake by Lemna minor partly due to the adenosine triphosphate deficiency.
Source: 1

#172
Buck, M. "Untersuchuchungen ueber die Wirkung von Luftverunreinigungen auf Pflanzen." (Experiments on the effect of air pollution on plants). Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands (1968) p. 53-73, Translated from German. Belov and Associates, Denver, Colo., 28 p., Sept. 15, 1970.

The use of indicator plants for detecting air pollutants and their range of distribution is gaining ground as a supplement to physical and chemical analyses of air. Plant reactions considered to constitute proof of pollution include the amount of pollutant accumulated and visible symptoms such as necrosis or the presence of certain kinds of lichen. It also seems likely that products produced by metabolic responses of a plant to absorbed pollutants are useful indicators. Combining these indicators with the specific sensitivity of individual plants or species could lead to manifold possibilities. Trials in progress involve the use of indicator chambers, which have an advantage over field indicators in that no damaging substances are absorbed through soil. Using combinations of indicator plants should permit identification of pollutants responsible for damage, even when several pollutants are simultaneously present, as in most industrial areas. A list is included of indicator plants suitable for sulfur dioxide, hydrogen fluoride, gaseous and stable inorganic fluoride compounds, and ozone.
Source: 1

#1138
Burns, L. S. "Urban Planning Aspects of Air Pollution Abatement." In: Paul B. Downing (ed.). The Contribution of the Social Sciences to the Sol'n. of the Air Pollut. Prob.: Task Force Assessment. Project Clean Air, Task Force #3, Sect. 7, Univ. of Calif., Berkeley (1970).

We emphasize that the very nature of urban planning requires the planner to be the coordinator on the one hand of relevant knowledge and on the other hand of action programs to bear on problems of the urban government. This ability of linking knowledge to action, we believe, could be an important contribution to transforming the results and findings of Clean Air Project into action programs.

Recommendations and findings of all the task-forces would be most effective in affecting changes in the urban environment if viable programs of action incorporating their findings could be formulated. The urban planner's experiences and expertise in formulation of action programs could be put to use for Project Clean Air by acting as the coordinator for the task of proposing action programs.

The first task will be the coordination of the knowledge gained by further research supported by the Project and the actions proposed by each separate task-force. Changes in institutions and proposals for intervention by the technologists and social scientists need to be first synthesized. Then a critical review using tradeoffs of costs, impacts, political feasibility, implementation techniques, effectiveness and expected problems of implementation need to be carried out.

A second task will be to make use of the knowledge gained from research from the first task to formulate action programs with detailed consideration of implementation. This will emphasize programs and proposals that employ the knowledge of all task forces. Pilot projects and case studies could be included as part of the action programs.

Thus the Project will present to the legislature and others involved with air pollution control a considered and well-coordinated synthesis of social and technical knowledge and their bearing on each other, and a proposal of action program that could be acted upon by the legislature.
Source: 5

#422
Bursche, Eva-Maria. "Vegetation damage by fluorine." Schaed reihe Ver. Wasser Boden Lufthyg. (Berlin), No. 10 (1955).

Laboratory tests were carried out to elaborate methods of recognizing and diagnosing plant damage produced by fluorine smoke. Brown to black ends and discolored edges were observed on leaves from open-air and artificially smoke exposed plants. The resistances of different plants were investigated. Microscopic observations revealed slightly creased epidermis and badly creased parenchyma. The cell-content formed a homogeneous brown mass in badly damaged leaves. Colorations due to fluorine and natural proccesses were separated in tissue investigations. Plasmolytic experiments were carried out for diagnosing chronic, acute, and invisible damage with NaF and NaCl. In Fontinalis antipyretica, 0.03% NaF-solution constituted the threshold limit while NaCl was much less harmful. No influence of the toxic effects of NaF and NaCl on the rate of plasmolysis could be revealed. Cells damaged by NaF (separation of protoplasts from the cell walls and slight plasmolysis) were regenerated after the normal conditions were restored. Hydrofluoric acid was more harmful than sodium fluoride. Elodea densa was damaged by a 0.0008% hydrofluoric acid solution. A special spectrophotometric method that permits determination of a typical acid effect only is explained. Chloro-

phyll extracts from damaged leaves showed a band of 535 micromicron, of different intensities depending on the actual fluorine content. Experiments were carried out to detect fluorine in plants by means of the methemoglobin method. A minimum of 0.01% of NaF in pure NaF solution could be satisfactorily detected. The method for dissolving the leaf material for fluorine detection is not sensitive enough. The characteristic fluorine-methemoglobin-hemoglobin band could be obtained for leaf material artificially damaged by 40% HF and ashed.
Source: 1

#403
Burschel, P. "Waldbau zwischen oekologie und oekonomie." [Forestry between ecology and economy]. Allg. Forstz., 29(8):153-158 (Feb. 23, 1974).

Ecological and economical problems of forestry are discussed. For the oxygen household of the atmosphere, forests have no importance. However, the roughness of forest surfaces influence the flow of air. Forests cause turbulence at the boundary between the forest and free atmosphere which improves the dispersion of pollutants. Not enough details are known yet about turbulence to permit any conclusions concerning measures taken by forest engineers. For avoidance of damage caused by air pollutants such as sulfur dioxide, fluorine, and chlorine, smoke resistant trees can be planted or deciduous trees instead of the more sensitive coniferous trees. The acidification of forest soil through SO2 can be combated by application of lime.
Source: 1

#768
Byrne, A. R. and L. Kosta. "Studies on the distribution and uptake of mercury in the area of the mercury mine at Idrija, Slovenia (Yugoslavia)." Vestn. Sloven. Kem. Drustva, 17(1/4):5-11 (1970).

Results are presented of a preliminary investigation of the mercury content of environmental samples, primarily of various water, soil, and plant samples, in the neighborhood of the mercury mine at Idrija, Yugoslavia. The measurement technique was activation analysis using a volatilization method for mercury separation. Results show a wide range from apparently normal background (0.005-0.1 ppm) to very high levels(10-100 ppm). The highest values are mainly due to aerial contamination from the mine flue gases. More importantly, the results show the ability of vegetation to accumulate mercury during growth.
Source: 1

#132
Caborn, J.M. "Shelterbelts & microclimates." Forestry Commission, Bulletin No. 29, Dept. of Forestry, Edinburgh Univ., Scotland, 135 pp. (1957).

The available evidence of microclimatic and associated biological influences of shelterbelts and their economic significance with regard to agricultural productivity and forestry practice is reviewed. The applicability of previous research to shelter requirements in Great Britain is considered and certain general conclusions regarding belt types, layout and structure derived. Possible extension of investigational work from a forestry aspect is outlined. Experimental technique and instrumentation for the study of shelterbelt effects on microclimatic factors, particularly wind, are examined in some detail. Fundamental research on two features of shelterbelt design, the effects of windbreak width and cross-sectional profile on the pattern of the leeward sheltered area, involved wind-tunnel studies. Field investigations of microclimate in the vicinity of tree belts concentrated on the assessment of their efficiency on the basis of their effect on wind abatement and their general structural and silvicultural condition, and were exploratory studies directed towards ultimate selection of ideal shelterbelt structures.

The width/height ratio in windbreaks has a significant effect in determining the extent and nature of the leeward sheltered zone; this may be apparent only when the degree of penetrability to the wind falls below a critical value, estimated to be 20 percent. Wide belts appear to lead the wind parallel to their upper surfaces with consquent, rapid, downward transfer of energy after leaving the leeward edges and restriction of the leeward eddy zone, giving rise to early resumption of the unobstructed wind velocity and a reduction of the distance protection afforded. Optimum belt widths will vary according to species and planting density; wide belts will exhibit a low efficiency index during their early years.

The fundamental effect of a slope on the windward margin of a windbreak is to minimize resistance to the normal flow pattern of the wind; this is of importance in connection with marginal protection of forests, but disadvantageous with regard to shelter near the ground. An inclined windward edge causes deflection of the major part of the air stream over the windbreak, thus reducing the effective degree of penetrability, similar to an increase in width. The sheltered zone is restricted to a degree dependent upon the acuteness of the angle of this gradient.

The sheltering efficiency of a belt may be determined by measurement of wind relationships within its range and subsequent comparison with corresponding values for a standard, moderately penetrable shelterbelt. This procedure offers a simple "rule-of-thumb" method for assessing treatment necessary to preserve or promote efficiency and ensure continuity of the stand. The shelterbelts studied are examined in the light of their present and potential efficiency.

The practical application of these results to the design and maintenance of shelterbelts and their contribution to eventual determination of the ideal shelterbelt are discussed, together with shelterbelt technique in forestry practice, modification of wind conditions in relation to the siting of shelterbelts on upland areas and possible aspects for future research.
Source: 8

#1152
Calder, K. L. "Absorption of ammonia from atmospheric plumes by natural water surfaces." Water, Air and Soil Pollution, 1(4):375-380 (1972).

A simple model is presented that incorporates the major features of atmospheric transport and diffusion of a NH_3 plume together with aqueous absorption as the plume traverses a water surface. The model is based on the well-known concept of the deposition velocity, although empirical data concerning the latter is quite meager. A specific application is considered to the gas release from a NH_3 stripper of a hypothetical sewage treatment plant, and it is concluded that NH_3 absorption by adjacent water masses could be considerable.
Source: 5

#263
Caldwell, R. L. "Mercury in the environment." Crops Soils Mag., 24(6):13-15 (March 1972).

Mercury is extremely widespread, with by far the greatest amount derived from natural sources. The mercury content ranges from 0.03 to 5 ppb in water; about 0.15 ppb in sea water; 30,000 ppb in coal and oil; from 3 to 1000 ppb in food; from 100 to 1000 ppb in non-food vegetation; and from 10 to 50 ppb in soil. Mercury levels in air vary with location, temperature, wind, and moisture, ranging from 0.7 ng/cu m in air over the open sea to 1 to 200 ng/cu m over land areas. It can reach levels 10 to 1000 times greater in air over deposits of mercury, copper, silver, and gold. It becomes airborne by volcanic eruption, biological activity, evaporation from natural deposits, and man's activities (from industrial waste and combustion processes). Its level in humans has decreased since many households are no longer heated by coal. While agricultural uses of mercury account for a small quantity of total mercury used, there are cases of mercury poisoning coming from fungicides and bactricides. Livestock was fed mercury-treated seed. The possibility of translocation of mercury to the germinated plant from the mercury-treated seed is still the subject of controversy. Cases of mercury poisoning in wild animals, particularly birds, have been reported. Miners, painters, dentists, and seed-treatment personnel, as well as people eating mercury contaminated food (the well-known Minamata disease and the New Mexico poisoning) are exposed to mercury. The symptoms of mercury poisoning are fatigue, headache, poor memory, blurred vision, numbness, emotional irritability, and coma. Mercury first accumulates in the liver and kidney, and later in the brain. Different forms of mercury may be converted biologically into methyl (organic) mercury, the most toxic of all. Alkyl mercury compounds are more easily converted into methyl mercury than aromatic (aryl) mercury compounds. Man's contribution to environmental pollution with mercury is significant, and should be minimized from all sources.
Source: 1

#936
Cameron, J. W., H. Johnson, Jr., O. C. Taylor, and H. W. Otto. "Differential susceptibility of sweet corn hybrids to field injury by air pollution." HortScience, 5(4):217-219 (August 1970).

Marked differential injury by air pollution to a group of sweet corn hybrids in two experimental field plantings in the Los Angeles Basin occurred in 1969. At Riverside, leaf damage ranged from nearly 0 in 11 hybrids to slight to severe in 23 others. Damage was clearly related to cultivar and was associated with periods of high oxidant levels and high maximum temperatures. There was only a slight relationship between the market maturity date of a cultivar and its degree of damage.
Source: 1

#937
Cameron, J. W., and O.C. Taylor. "Injury to sweet corn inbreds and hybrids by air pollutants in the field and by ozone treatments in the greenhouse. J. Environ. Quality, 2(3):387-389 (1973).

Five inbreds of corn (Zea mays L.) and three of their F1 hybrids were grown in the field under natural summer air pollution conditions in 1971. During the following fall, four of the inbred and two hybrids were grown in greenhouses and received controlled ozone treatments. The cultivars showed highly significant differences in injury under field conditions, but much smaller differences in the greenhouse tests. In the field, four inbreds were relatively resistant; the fifth was highly susceptible. The three hybrids showed some correlation with the resistance of their parents. In the greenhouse, with repeated dosages of O_3, all tested inbreds showed substantial damage when 4 to 7 weeks old, but at flowering, the field-susceptible inbred was the most severely damaged. The hybrids also showed severe damage as young plants, while at flowing, their damage from greenhouse treatments was related to their field susceptibility. Injury symptoms in the field were typical of O_3 injury in the greenhouse. In all cultivars, young leaves were less injured than fully mature leaves.
Source: 1

#173
Cannon, H.L. and J.M. Bowles. "Contamination of vegetation by tetraethyl lead." Science, 137:765-766 (Sept 7, 1962).

Vegetation growing near highways was tested for tetraethyl lead in three areas: Denver, Colorado; Canandaigua, New York; and Washington County, Maryland. Washed pasture grass near Denver contained 3000 ppm (in ash) near major intersections and more than 50 ppm for 500 ft. downwind. In Canandaigua, vegetables grown less than 50 ft. from the street averaged 115 ppm lead and ranged from less than 10 to 700 ppm in contrast to an expected background of less than 5 to 20 ppm. Samples of vegetables collected within 25 ft. of roads in Washington County contained an average of 80 ppm lead, but samples collected more than 50 ft. from a road averaged only 20 ppm lead.
Source: 1

#938
Cantwell, A. M. "Air pollution in Delaware and its effect on plants under ambient and controlled environmental conditions." Delaware Univ., Newark, Dept. of Plant Pathology, Thesis (M.S.) (June 1969) 92 p.

Air pollution investigations in Delaware identified the major plant toxic pollutants as ozone and sulfur dioxide, both contaminants undergoing a yearly cycle. Daily cycles were also observed for the pollutants. Climatic conditions correlated with high pollution levels; and highest ozone levels occurred on days of high temperature, high barometric pressure, and little sky cover. Greenhouse tests proved that present ambient levels of ozone and SO2 are causing damage to sensitive plants. Low levels of the growth regulant Algar reduced damage from ozone on lima bean to negligible amount in laboratory tests. Plants were sensitized toward ozone by treatment with an iodide-bromide solution; such a procedure appeared useful as an ideal biological indicator of air pollution since the sensitized plants responded to the lowest levels of ozone detectable on conventional electrochemical analyzers.
Source: 1

#1159
Cappellini, R. A., and Z. Eyal. "Sorption of SO_2 by Latham red raspberries and their containers." Plant Disease Reporter, 48(11):879-880 (November 15, 1964).

The rate of sorption of SO_2 by Latham red raspberries and their containers is measured. The sorptions rate is greatest during the first 10 minutes of fumigation and is given in a table. Treatment with SO_2 reduced post harvest decay on the berries, however, high SO_2 dosages did cause injury to the fruit. This is shown in a second table.
Source: 6

#939
Carlson, C.E. "Fluoride in vegetation near a phosphorous manufacturing plant in the vicinity of Butte, Montana." Insect Dis. Rep., 70(3):1-5 (February 1973).

The fluoride content of vegetation at seven sites near a Butte, Montana, phosphate facility was determined with a specific ion probe. Amounts ranged from 9.4 ppm in Douglas fir foliage to 74.2 ppm in crested wheatgrass foliage. All but two analyses showed more than 10 ppm fluroide, the control level established at Columbia Falls. The State standard of 35 ppm for fluoride in plants was exceeded at three sites within one mile of the facility. No visible symptoms of fluoride injury were observed on coniferous foliage.
Source: 1

#940

Carlson, C.E. "Fluoride pollution in Montana." Fluoride, 6(3):127-137 (July 1973).

An intensive study of the effect of airborne fluorides on vegetation was undertaken in 1970 in the vicinity of an aluminum production plant in northwestern Montana. Fluorides greater than control levels (10 ppm) were found in vegetation over a region of 214,000 acres, and visual fluoride injury to conifers occurred in an area comprising 69,000 acres. Histological reactions characteristic of elevated fluoride levels occurred in conifer needle tissue, including hypertrophy of parenchymatous tissue. Forest insects were found to accumulate fluorides. Analyses of predaceous insects for fluoride indicated that fluorides are likely to be carried through the food chain. Even though the company reduced fluroide emission by 67% between 1970 and 1971, data collected in 1971 indicated that vegetation in Glacier National Park, 7 air miles distant from the source, was still accumulating abnormal amounts of fluoride.
Source: 1

#941

Carlson, C. E. "Sulfur damage to Douglas-fir near a pulp and paper mill in Western Montana." U.S. Dept. of Agriculture, Missoula, Montana, Division of State and Private Forestry, Report 74-13, 5200, 42 p. (April 1974).

Serious needle browning, not caused by parasitic fungi or insects, occurred on Douglas-fir over 5200 acres of forested lands during the winter of 1972-1973 near a paper and pulp mill at Missoula, Montana. Severity of the damage increased at decreasing distance from the mill; and total foliar sulfur content ranged from .00 to .63 in the area, with highest concentrations found in the most severely affected locations. Average sulfation rate was 1.52 mg sulfur trioxide/sq cm/day in the severely affected area and .96 mg SO_3/sq cm/day in a lightly affected area. Plant symptoms as a whole were similar to those caused by excessive airborne sulfur compounds. Histological analyses of affected foliage showed the mesophyll cells to be affected first (plasmolysis and collapse), followed by hypertrophy and collapse of parenchyma in the vascular system.
Source: 1

#1841

Carlson, R. W., F. A. Bazzaz, J. J. Stukel. "Physiological effects, wind reentrainment, and rainwash of Pb aerosol particulates deposited on plant leaves." Depts. of Botany, C. E., M. E., Univ. of Illinois. Urbana. (No date).

Leaves of soybeans (Glycine max L.) were experimentally fumigated with $PbCl_2$ aerosol particulate. No indication was found for either an effect of Pb on photosynthesis or for intra-plant movement of topically applied Pb. Reentrainment windspeeds up to 6.7 m s^{-1} had no effect in removing aerosol particulate while simulated rainfall removed up to 95% of the topically applied Pb. The mechanism of dissolution or suspension and subsequent runoff appears to predominate over that of bombardment and resultant splashoff for rain water removal of $PbCl_2$ particulate from soybean leaves.
Source: 7

#942

Carney, A.W., G.R. Stephenson, D.P. Ormrod, and G.C. Ashton. "Ozone-herbicide interactions in crop plants." Weed Sci., 21(6):508-511 (November 1973).

Tomato, white bean, and tobacco plants were pretreated with various herbicides prior to fumigation with ozone concentrations between 0 to 30 pphm for two 1.5 hr periods to test for synergistic or antagonistic interactions. The natural logarithms of the dry weight data were subjected to multiple regression analysis. Synergistic phytotoxicity was definitely observed for the herbicide pebulate and possibly for chlormben in combination with ozone on tobacco; while for most of the other combinations the phytotoxicity in the presence of ozone was additive, with no interaction being indicated. An antagonistic interaction between ozone and benefin was indicated on the tobacco cultivars.
Source: 1

#943

Case, J. W. "The use of lichens as bio-indicators of sulphur dioxide." Environment Canada, Edmonton (Alberta), Canadian Forestry Service and Northern Forest Research Centre, and Alberta Environment, Research Secretariat, Proc. Workshop Sulphur Gas Res. Alberta, Edmonton, Alberta, p. 120-128 (November 1-2, 1973).

Lichens are sensitive to sulfur dioxide and other pollutants and may be used to measure pollution. The correlation between air pollution and lichen distribution has been substantiated in many studies. Many techniques have been used to correlate the distribution of lichens around air pollution sources including Zone mapping, Index of Atmospheric Purity (IAP) mapping, and transplants. An IAP may can be used to show the total area affected, to present a relative picture of the pollution concentrations, and to show the long-term effect of the sulfur dioxide emissions on the epiphytic lichens. The map could be used in settling disputes as to the effects that SO_2 from a sulfur extraction gas plant has on various components of the surrounding countryside. Zone mapping has limited application in Alberta because the ecology of most lichen communities has not been adequately studied. Transplant studies are more time consuming than the IAP mapping method, although they are useful as a backup to IAP mapping.
Source: 1

#174

Cass, J. S. "Fluorides: A critical review. IV. Response of livestock and poultry to absorption of inorganic fluorides." J. Occupational Med., 3(10): 471-477 (October 1961).

Author reviews the biological and toxic effects of fluorides on animals. Presented are two charts depicting the response of domestic animals to various levels of fluoride dosage, minimal response and lethal response. A portion of the review is directed to intoxication and poisoning by fluorides and the conclusion by the author is there is no evidence in the literature of the development of a satisfactory or certainly beneficial treatment for animals that have been poisoned by fluoride, aside from symptomatic or supportive measures.
Source: 1

#141
Cassidy, S.G. "The effect of cyclic salt in a maritime environment. II. The absorption by plants of colloidal atmospheric salt." Plant & Soil, 28: 390-406 (1968).

A previous paper (Part I) has shown that when vegetation and land slope are favorable to the capture of aerosol, the salinity of rainfall provides no measure of rate of acquisition of cyclic salt by a given land area. This is confirmed by the high level of chloride in Fiji foliage. The chloride content of experimental rice plants was found to be much higher than could be accounted for by all the chlorides introduced into the growth medium. Rice plants in the field, affected by the punctures of leaf hoppers, were shown to have a higher level of leaf chloride than unaffected plants. Chloride absorbed through the leaves was distributed in the plant differently from chloride taken up by the roots. Measurements on stomata and specific leaf area suggest that the aerosol particles enter through the stomata rather than through the rest of the leaf surface.
Source: 7

#1032
Cestonis, A.C. and W.A. Sinclair. "Ozone injury to Pinus strobus." J. Air Pollution Control Assoc., 19(11):867-872 (Nov. 1969).

In a study of the ozone induced needle blight of eastern white pine in central New York, acute injuries naturally induced in field trees during a year of relatively low ozone concentration (1966) were compared with injuries induced during a year of higher concentrations (1967). Injuries were more frequent and severe and were associated with higher mean ozone concentrations in 1967 than in 1966. Characteristic symptoms were induced on foliage of pine branches exposed to controlled doses of ozone as low as 7 + or 1 pphm for 4 hr or 3 + or -1 pphm for 48 hr. Such doses were equalled or exceeded two and four times respectively, in the field during the 1967 season. Ozone sensitivity of pine needle tissue was increased by fumigation in atmospheres containing water mist. High concentrations of ozone (40-60 pphm) caused general injury of foliage of both ozone susceptible and resistant trees; the symptoms were unlike those found in the field or caused by fumigation with low concentrations of ozone.
Source: 1

#97
Chadwick, R. C., and A. C. Chamberlain. "Field loss of radionuclides from grass." Atmospheric Environment, 4:51-56 (1970).

Solutions of ^{85}Sr, ^{51}Cr and ^{210}Pb were sprayed onto grassland, and the initial retention by the herbage and subsequent rate of field loss by weathering were measured. A similar experiment was also done with a spray containing a suspension of 1 μm dia. polystyrene particles, tagged with ^{51}Cr in insoluble form.

The activity initially retained by the herbage was on average 40 per cent of that applied in the spray. The subsequent field loss corrected for radioactive decay gave retention half lives of ^{85}Sr as chloride of about 19 days in summer and 49 days in winter. The rate of loss of ^{51}Cr as chromate was not greatly different from that of ^{85}Sr, and similar results also were obtained in the single experiment with tagged particles, but the rate of field loss of ^{210}Pb appeared to be somewhat less.
Source: 7

#116
Chamberlain, A. C. "Interception and retention of radioactive aerosols by vegetation." Atmospheric Environment, 4:57-78 (1970).

The efficiency of vegetation as a filter for nuclides deposited on the earth's surface is examined. The proportion of the fallout initially retained in the herbage, p, is assumed to be related to an uptake coefficient u (m^2kg^{-1}) by the relation $1-p=\exp-\mu w$, where w is the herbage density in kg m^{-2} dry matter. Experimental values of μ lie in the range 2.3 to 3.3 m^2kg^{-1}, and there does not seem to be any marked dependence on the physical form of the activity.

The rate of loss of activity by weathering from foliage is next considered. The field loss coefficient λ_b has been found to be of order 0.05 $days^{-1}$ in field experiments during the growing season, but lower values (corresponding to longer retention periods on the foliage) have been observed in winter.

Representative values of p and λ_b are then used to calculate the normalized specific activity of herbage continuously exposed to fallout, where

$$\text{N.S.A.} = \frac{\text{Activity per kg dry matter on foliage}}{\text{Activity deposited day}^{-1}\ \text{m}^{-2}\ \text{of ground}}$$

The calculations give N.S.A. values ranging from 27 to 55 m^2 days kg^{-1} depending on the value assumed for λ_b and for the time T_o between successive croppings of the herbage.

Finally, surveys of the activity of ^{90}Sr and ^{137}Cs in the U.K. and abroad are used to deduce the N.S.A. of foliage exposed to world-wide fallout from weapon tests. Good agreement with the calculated values is obtained, but there is evidence of enhanced N.S.A. values in poor growing conditions.
Source: 7

#108
Chamberlain, A.C. "Deposition of particles to natural surfaces." In: Airborne Microbes, P.H. Gregory and J.L. Monteith (eds.), 17th Symp. Soc. Gen. Microbiol., Cambridge Univ. Press, London.

Discusses the deposition to surfaces of particles in the size range 1-50 μ. Impaction is principle means of deposition provided particle dimensions are of order 10 μ or more; the obstacle dimensions are of orders cm's or less; approach velocity is of order meters 18 cc or more; and the surface is wet, sticky or otherwise retentive of particles. 1-5 μ particles are most effectively caught by five hairs on vegetation. 1 μ particles are mostly influenced by Brownian motion-nature of surface is not as important as for larger particles. Conditions found in forest where canopy restricts air exchange most nearly approach those found indoors (in terms of particle deposition).
Souce: 7

#1160
Chamberlain, A.C., and R. C. Chadwick. "Deposition of spores and other particles on vegetation and soil." Am. Appl. Biol., 71:141-158 (1972).

The rate of deposition of 20-30 um diameter particles, including spores and pollen grains, on plant and other surfaces, is determined, first, by the frequency at which particles strike the surfaces and, secondly,by the proportion retained on the surface rather than rebounding into the airstream.

Spores and pollen grains tagged with a radioactive marker were used to show that the impaction efficiency on leaves and stems depends very much on whether or not the surfaces are sticky or moist. If they are, the rate of deposition may approach that predicted aerodynamically. If the plant surfaces are dry, there is saltation of some spores and the effective rate of deposition is greatly reduced.
Source: 6

#423
Chang, C.W. "Effects of ozone on sulfhydryl groups of ribosomes in pinto bean leaves, relationship with ribosome dissociation." Biochem. Biophys. Res. Commun., 44(6):1429-1435 (September 17, 1971).

The effect of ozone on sulfhydryl groups of ribosomes in pinto bean leaves and the relationship with ribosome dissociation were studied. Chloroplast and cytoplasmic ribosomes were isolated from the primary leaves of control and ozone-treated pinto bean plants. The levels of ribosomal sulfhydryl groups and their responses to 5,5-dithiobis (2-nitrobenzoic acid) were analyzed on the basis of a unit of ribosomal protein. The sedimentation profile of ribosomes were determined by the sucrose density gradient. Exposure to 0.30 ppm of ozone for 20-50 min decreased the levels of sulfhydryl groups in chloroplastic ribosomes far more than in cytoplasmic ribosomes. Ozone and p-chloromercuribenzoate directly dissociated polysomes and monosomes of isolated chloroplast ribosomes into smaller particles in vitro. The levels of sulfhydryl which reacted with 5,5-dithiobis were higher in chloroplast than in cytoplasmic ribosomes and were completed much faster. Based on this data, the preferential influence of ozone on the disintegration of chloroplast ribosomes in bean leaves is discussed.
Source: 1

#944
Chang,C.W., and H.E. Heggestad. "Effect of ozone on photosystem II in spinacia oleracea chloroplasts." Phytochemistry, 13(6):871-873 (1974).

Spinach plants were treated with 0.35 ppm of ozone, and the photochemical activity of the photosystem II was determined after separation from the isolated chloroplasts using digitonin. Ozone impaired the activity of the system and reduced the amount of beta-carotene in the chloroplasts.
Source: 1

#424
Chapman, D.J. and R.D. Tocher. "Occurrence and production of carbon monoxide in some brown algae." Can. J. Botany, 44:1438-1442 (1966).

Quantitative data on carbon monoxide in some brown algae, Pelagophycus porra and Pelagophycus giganteus, are reported and preliminary experiments on the production of CO in the pneumatocyst of Nereocystis luetkeana are described. CO measurements followed the spectrophotometric method of Allen and Root, modified by use of a simplified reaction vessel. Pneumatocysts of Nereocystis will regenerate CO for several days when kept in the laboratory. However, this generation will only occur when air is present in the pneumatocysts.
Source: 1

#425
Chasseraud, J. "Influences du milieu un ain sur les vegetaux employes dans les espaces verts: Conclusions et techniques qui en decoulent." [Influence of the urban atmosphere on plants used in parks and gardens: Forthcoming conclusions and techniques]. Proc. Intern. Congr. Horticulture, 15(3):60-74 (1958).

The conditions of plants in parks and gardens relative to the atmosphere and to the soil are discussed. A tall building can modify the life conditions of nearby trees, since a new microclimate is established. In the urban atmosphere, conifers appear to be the most sensitive to the presence of atmospheric pollutants. These pollutants most often come from combustion sources and internal combustion engines. The leaves of plants are well suited to retain the fine elements of particles, particularly tars and oils. By settling on the leaves, these substances form a film which reduces the respiration and chlorophyll function of the plant. Among the conifers, spruce and douglas are the most sensitive to sulfur dioxide; among the broad leaved trees, elm, birch, and catalpa are relatively sensitive. The distribution of pollutants is influenced by topographic factors and meteorological conditions. The tendency toward stagnation, accompanied by the accumulation of pollutants, is prevalent in shelter areas and in areas where the air is stable. Temperature inversions cause an accumulation of noxious products near the soil and are, therefore, detrimental to plant life. It is recommended that resistant species of plants be selected for the parks and gardens of urban areas. The soil conditions which affect plant growth are also discussed in detail.
Source: 1

#315
Cheo, P.C. "Some common diseases of ornamental plants in the Los Angeles area." Lasca Leaves, 21(2):36-45 (June 1971).

Common diseasss of ornamental plants in the Los Angeles area were studied and correlated to unfavorable environmental conditions, e. g., exposure to industrial emissions of sulfur dioxide, ozone, peroxyacetyl nitrate, nitrogen oxides, fluoride, and ethylene gas; nutritional disorders, e. g., lack of water, poor drainage, soil alkalinity, lack of organic matter, and salt buildup; and parasitic organisms (bacteria, fungi, viruses, phanerogamic and nematodes). Specific causes and characteristics of certain diseases, the plants they attack, and possible cures are examined.
Source: 1

#107
Chillote, D. O. "The role of plants in removal of air pollutants." In: Plants in Environmental Purification. Environmental Health Science Center, Oregon State University, p. 23-29 (1975).

General review of literature which suggests plants' role in removal of air pollutants. Among pollutants considered are lead, SO_2, flouride, CO and CO_2 particulate material. Suggests that work be done in area of plant breeding in order to evaluate capacity of plants to remove air pollutants. Other organisms, e. g., lichens, should be examined as well.
Source: 7

#426
Chisnall, K. T., and J. Markland. "The contamination of pasture land by lead." (Presented at the Association of Public Analysts, Annual Conference, Matlock, England, May 13-15, 1971). J. Ass. Pub. Anal., 9:116-118 (Dec. 1971).

Following the death of several cattle and two ponies on a farm adjacent to waste heaps from old lead mine workings and near a lead smelter, grass samples from a number of fields were analyzed for lead. The amount of lead (80-520 ppm) in grass from 11 fields was high enough to support the diagnosis of lead poisoning. The presence of antimony in the grass in a high ratio relative to lead suggested that the contamination originated in the lead mine waste, and not in smelter fumes.
Source: 1

#2
Chow, T. J. " Biogeochemical implications of lead in the hydrosphere." In: Project Clean Air. Scripps Institution of Oceanography, La Jolla, Calif., California Univ. Task Force Assessments, Vol. 2, App.-F, pp. 1-23 (1970).

Present knowledge of the occurrence and toxicity to living organisms of lead in fresh and saline waters is reviewed. Lead pollution of the hydrosphere originates overwhelmingly from the burning of lead alkyl additives in automotives fuels; the resultant lead aerosols suspended in the atmosphere will eventually enter bodies of water as runoff or precipitation. The use of the characteristic isotopic compositions of various lead ore deposits makes possible the identification of the source of lead pollutants. An historical increase in lead pollution has been found by analysis of precipitated lead in chronological layers of old preserved snow strata. The concentration of lead in sea water is very low and difficult to measure; for fresh water, the global mean lead content appears to lie between 1 and 10 micrograms/l. Lead poisoning in humans is reported from drinking water levels from 42-1000 micrograms/l or more, but it is possible that 100 micrograms may cause chronic poisoning if the water is used continuously. Farm animals are frequent victims of lead poisoning from water. For aquatic communities, lead pollution appears to reduce the number of species and individuals; fish are the most sensitive. Toxic lead need not necessarily be in solution but may be in suspension. Lead is less toxic in hard water streams than in soft waters. Recommendations for lead pollution control are made, and topics for future research suggested.
Source: 1

#945

Chrosciel, S., J. Juda, and J. Palluch. "Methodik der Beurteilung des Gefaehrdungsgrades von Waldkomplexen durch Bestimmte Emmissionsquellen." (Methods of evaluating the degree of danger to forest associations by certain sources of air pollution). (Presented at the International Symposium of Forest Fume Damage Experts, 7th Essen, West Germany, Sept. 7-11, 1970). Text in German Mitt Forst. Bundesvers, 97:473-479 (1972).

A method is presented for determining the degree to which particular industrial plants contribute to tree-stand damage and for forecasting the degree of air pollution which will arise from projected new emission sources. The problem as a whole has been adapted for calculation by computers. This enables the application of sections of maximal accuracy and the introduction of a wide range of meteorological coefficients. The question of the proper choice of diffusion coefficients has been solved in an entirely original manner. A method of combined calculations has been developed making use of the forest associations themselves as indices of the spread of pollution. The corrected dose of pollution has been introduced as a measure of the influence of pollution on woods. This is the sum of the pollution concentrations through the relevant periods of time of their occurrence S.t. multiplied by the function f/S.t./. The introduction of the function f/S.t./ is to correct the established dose of pollution in proportion to the degree of damage to the woods. Both initial and calculating formulae are given, as is a computer calculation program.
Source: 1

#1480

Cionco, R. M. "A mathematical model for air flow in vegetative canopy." J. Appl. Meteorol., 4:571-522 (1965).

The objectives of this study are to investigate the turbulent transfer of momentum within a vegetative canopy and also to develop a mathematical model which expresses the aerodynamic roughness effects of the surface boundary in terms of the height, density, and drag characteristics of a vegetative canopy. To date three mathematical models have been formulated. The present model reflects both the theoretical and empirical aspects of the two previous models and other available canopy observations. Computed mixing length solutions showed that the mixing length, l, was nearly constant throughout most of the canopy's vertical extent and also that l increased linearly with height above the canopy. The computed canopy wind profile solutions verified that the mixing length is nearly constant with height within a mature corn plant canopy and that the simulated canopy wind profiles agreed quite well with the observed canopy wind data of a cornfield. An independent check on the model was performed using wind tunnel data for an artificial canopy; once again the simulated canopy wind profiles were in good agreement with the observed data. Example profiles of the mixing length and the canopy wind profiles are presented along with simple scatter diagrams to summarize the analysis of the model data.
Source: 5

#1161
Coale, A. J. "Man and his environment - economic factors are more important than population growth in threatening the quality of American life." Presented at Chapel Hill, N. C. at a Symposium on Man and His Environment. (March 19, 1970).

The author is critical of the activities of man that are altering the environment. He discusses some ideas that may be put into action to aid in rectifying the situation. Also, the author writes about resource exhaustion, population growth in U. S., connection between population and pollution and policies that would affect the growth of population.
Source: 6

#946
Cobb, F.W. Jr., E. Zavarin and J. Bergot. "Effect of air pollution on the volatile oil from leaves of Pinus ponderosa." Phytochemistry, 11(5): 1815-1818 (1972).

The composition of the essential oil from the leaves of photochemical air pollution injured and healthy Pinus ponderosa trees was determined. Methyl chavicol, a product of the carbohydrate-shikimic acid metabolism, was strikingly lower in the injured trees. However, no significant differences were observed in the monoterpenoids. The effects paralleled qualitatively the influence of needle aging on the essential oil composition, i.e. the effect of air pollution represents an accelerated senescence.
Source: 1

#1027
Cocking, W. D. "Plant community damage and repairability following sulfur dioxide stress on an old field ecosystem." Rutgers Univ., New Brunswick, N.J., Dept. of Botany, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., order no. 74-8769, 144 p. (1974).

Parcels of a first-year old field on the New Jersey Piedmont were fumigated in translucent polyethylene chambers with single 1 ppm sulfur dioxide stresses for 4-hour periods throughout the 1971 growing season and also during the 1972 (single and repeated stresses) to examine plant damage and repairability effects in the community. Vegetation was clip sampled in treated and control herbage 1 week subsequent to each fumigation and at the end of the growing season in September. An overall quantitative evaluation of the impact on the community, which included both the magnitude of the initial damage to the system and the regrowth pattern of the plant community during the repair period, showed that there was a 17.0% reduction compared to control vegetation in the amount of photosynthetic surface area totaled over each day of the post-initial treatment growing season after a single stress. The reduction was 23.8% in the case of repeated stresses if the interval between fumigations was brief and 31.6% if the stresses were separated by a half a month. The total community impact of more widely spaced sulfur dioxide perturbations of the same intensity was thus greater than that of the same stresses occurr over a brief interval
Source: 1

#1448
Cole, A. L., and J. B. Harrison, Jr. "Air pollution by ragweed pollen. III. atmospheric dispersion of ragweed pollen." J. Air Pollution Control Assoc., 17(10):654-656 (October 1967).

Study of atmospheric dispersion of ragweed pollen is complicated by its abundance and widespread distribution in the atmosphere. Artificially reared ragweed plants which flower and pollinate some two months in advance of the normal season were used for experiments to determine flotation and transport mechanisms. Atmospheric pollen sampling methods which are discussed include gravity slide, volumetric and impaction samplers.
Source: 1

#769
Coleman, C. H. "How Plants Test Air. Org. Gardening Farming, 1961:71-78 (March 1961).

Although laboratory tests tell when phytotoxicants are present in the atmosphere, only plants will tell when they combine to form fog-burn contaminant injurious to crops. Moreover, in many instances, plants provide the first warning of early air pollution. The reliance scientists place on plant indicators is exemplified by a San Francisco program in which plant data is fed into electronic machines to determine the extent and origin of pollution damage. Plants susceptible to air pollution are listed and the effects of oxidants, ozone, fluorides, sulfur dioxide, ethylene, smog, and herbicides on plants are summarized. It is noted that air pollution damage to crops is $7 1/2 billion per year and that plants will become increasingly important for monitoring pollutants.
Source: 1

#1967
Collins-Williams, C., H. K. Kuo, E. A. Varga, S. Davisdon, D. Collins-Williams, and M. Fitch. "Atmospheric pollen counts in Toronto, Canada, 1971." Ann. Allergy, 31(2):65-68 (Feb. 1973).

Daily atmospheric pollen counts were determined in Toronto for 1971. The sampling and analytical techniques are reviewed. The tree pollen season extended from the first week of April to the middle of July with the peak in early June; the grass season from the first week of May to the end of July with the peak in the middle of July; the ragweed season from the second week of August to the middle of September with the peak in the first week of September. Miscellaneous weed pollens were determined from the middle of May to the first week of November. Pollen counts for the common tree species, comparisons with pollen patterns in 1954, and pollen counts for the miscellaneous weed pollens are discussed.
Source: 1

#427

Comeau, G., and F. LeBlanc. "Influence de 1 ozone et de 1 anhydride sulfureux sur la regeneration des feuilles de Funaria hygrometrica HEDW." (The influence of ozone and sulphur dioxide on the regeneration of Funaria hygrometrica HEDW leaves). Translated from French. Natur. Can., 98:347-358, (1971).

The regenerative power of Funaria hygrometrica leaves after exposure to various concentrations of sulfur dioxide and ozone for different lengths of time was studied. With O_3 the percentage of regenerations is inversely proportional to the length of exposure and to the concentration for fumigations of 6 and 8 hr. With SO_2 the percentage of regenerations is inversely proportional to the length of exposure and to the concentration for fumigations of 4, 6, and 8 hr. Ozone has a stimulating effect when administered for short periods. Leaves coming from the upper part of the stem have a higher percentage of regeneration than those of the lower part.
Source: 1

#1481

Committee on Chemistry and Public Affairs. "Cleaning our environment: the chemical basis for action." Amer. Chem. Soc., Washington, D. C., 20p. (1971).

The author states that the actual extent of air pollution is virtually unknown. Certain effects have been caused by air pollution. If there are global pollutants, the natural level cannot be determined. "Other substances are being introduced into the atmosphere continually, so that information on natural levels is lost with each day the atmosphere is not monitored." The society recommends a system of obtaining data on the global pollutants. The problems of studying one city or region are observed and some ideas that may eliminate the problems are presented. Also, the society recommends investigating the impact of air pollutants on an entire food chain. The committee recommends improved instrumentation for measuring automobile emissions and also, an improved system of investigation of auto emissions. Another subject in which the society submits reccmmendations is fossil fuel combustion.

Besides being concerned with the air environment, the society recommends further studies and improvements in the water environment, solid wastes, and pesticides. In regards to the water environment, the society promotes improvement in the public water supplies, condemns eutrophication, and requires more information on pollutant inventories and joint municipal-industrial treatment. The recommendations involve municipal refuse and junked automobiles. The eight recommendations concerning pesticides are more extensive educational programs, decrease in the use of persistent pesticides, more efficient pesticide monitoring programs, integrated methods of pest control, increased investigation of the effects of pesticides on biological systems.
Source: 5

#1488

Commoner, B. "Threats to the integrity of the nitrogen cycle: Nitrogen compounds in soil, water, atmosphere and precipitation." Global Eff. Environ. Pollut., Symp., Dallas. p. 70-95. (1968).

In addition to the stress placed on the natural nitrogen cycle by the growth of urban populations in the last generation, there are two main technologic stresses: the introduction of inorganic nitrogen fertilizers into the soil, and the introduction into the air of nitrogen oxides from automobiles and other combustion processes (in addition to nitrogen oxides released from the soil). The former i manifested by severe eutrophication of surface waters in heavily farmed areas and excessive nitrate levels in some vegetable products, causing health risks from methemoglobinemia, and the latter by a noticeable increase in the last 25-30 years in the inorganic nitrogen content of precipitation. Data on these effects are reviewed, examples cited, and the economic, social, and political implications of possible remedies are considered.
Source: 1

#1028

Compton, O.C., F.W. Adams, S. Elliott, J.H. Wood, D.W. Claypool, and R.K. Marsh. "Fluroine levels in plants of the Warrenton Area, 1968-1970: Cultivated and native woody and herbaceous plants prior to aluminum factory operations." Oregon Agricultural Experiment Station, Corvallis, Rept. 335, 30 pp. (July 1971).

The flourine level of plants in an area intended for construction of an aluminum plant was studied to supply reference data in anticipation of pollution after start of plant operation. Cultivated and native plants within 6 mi of the factory site were sampled. Pasture herbages contained an average of 0.8-3.2 ppm fluorine, with only 11% of the samples exceeding 3.4 ppm. The fluorine content of each of the other six species averaged 2.9 ppm, with the exception of spruce needles containing 4.2 ppm. Five improved strains of pasture grasses maintained in pure strands were consistently and uniformly low in fluorine content. Within the area, differences in terrain, river valley, or distance from projected factory site produced no trends in fluorine concentrations.
Source: 1

#428

Connor, J. J., J. D. Sims, and R. J. Ebens. "Roadside effects on trace element content of some rocks, soils, and plants of Missouri." Proc. Missouri Univ. Fourth Annu. Conf., Columbia, p 26-34. (June 23-25, 1970).

A study to estimate the effect of roadside location on trace element content of rocks, subsurface soils, and vegetation demonstrates that the major effect is that of lead accumulation in vegetation. Soils taken from a few inches depth both near pavement and away from pavement exhibit no significant differences in metal content, including Pb. Some higher trace element contents of bedrock in roadcuts were noted in this investigation, but these are believed to reflect specific geologic conditions, rather than general roadside effects. The roadside effect on the Pb content of vegetation reflects mostly automotive exhaust from normal vehicular activity.
Source: 1

#1029
Coppins, B. J. "The Drought Hypothesis." In: Air Pollution and Lichens. B.W. Ferry, M.S. Baddeley, and D.L. Hawksworth (eds.), Toronto, Toronto Univ Press, Chapt. 7, p. 124-142 (1973).

The drought hypothesis which claims that atmospheric dryness rather than pollution is responsible for the lack of urban lichens is discussed. Dr. Jan Rydzak rejects claims of the sensitivity of lichens to the levels of sulfur dioxide normally found in towns and around isolated industrial plants. Rydzak considered the zonation patterns seen in urban lichen floras to be due to adverse microclimatic conditions, particularly the lowering of humidity, increased temperature, and an increased frequency of drying/wetting regimes. Arguments are presented for the hypothesis, but many cannot be substantiated by field and laboratory investigations. Sulfur dioxide in the air can better explain the changes which have occurred in the lichen vegetation in both urban areas and the rural areas surrounding them. City induced drought may have some effect on those species able to withstand the current SO_2 levels in cities, but this is not likely to be important in suburban and surrounding rural areas. Some data tentatively indicate some correlation between relative humidity and SO_2 effects under experimental conditions. These effects would be limited to the most hygrophilous species able to survive the prevailing SO_2 levels. Source: 1

#770
Costonis, Arthur C. "The relationships of ozone, Lophodermium pinastri and Pullularia pullulans to needle blight of eastern white pine." Cornell Univ., Ithaca, N.Y., Dept. of Plant Pathology, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 176 p. (1968).

The individual and combined roles of ozone and the needle fungi, Lophodermium pinastri and Pullularia pullulans were studied in the field and under controlled laboratory conditions to assess their role in needle blight of eastern white pine. In symptomatology and etiology, ozone injury on eastern white pine has much in common with emergence tipburn, chlorotic dwarf, red needle and yellow dwarf blight. Characteristic symptoms include flecking, spotting, banding, tip necrosis, dwarfing, premature castling of needles and slower growth of genetically susceptible trees. Ozone injury simultaneously induced a variety of symptoms on different white pines according to their inherent sensitivities and seasonal trends in sensitivity. Three grades of sensitivity were recognized. Factors which favored ozone injury were high temperatures, high relative humidity, bright sunlight during and after fumigation, and free moisture on the needles during exposure. Needles were most sensitive to ozone injury from about one week after needle emergence until they were about six weeks of age. In 1967, a year of relatively high ozone concentration, more injury occurred than in 1966, a year of relatively low ozone concentrations. New needles of sensitive trees protected from the ambient atmosphere by means of polyethylene bags or by growing the trees in a charcoal-filtered air environment remained healthy. As a result of artificial inoculations of attached and detached needles, Pullularia pullulans only invaded tissue previously killed by ozone while Lophodermium

pinastri infected both fumigated and non-fumigated sensitive and tolerant needles. Spores of L. pinastri usually germinate by the production of appressoria which become thick walled and melanized. Apparently the fungus penetrates the cuticle directly, as no stomata penetration was observed. The greatest impact of needle blight on eastern white pine is probably of growth rate and associated fibre production.
Source: 1

#1033
Costonis, A. C. "Acute foliar injury of eastern white pine induced by sulfur dioxide and ozone." Phytopathology, 60:994-999 (1970).

Ramets of eastern whitepine (Pinus trobus) were exposed to both sulfur dioxide and ozone in a controlled environmental chamber. Current needles between 4 and 5 wk old were acutely injured by SO_2 at dosages ranging from 15 + or -5 pphm for 2 hr to 5 + or - 1.5 pphm for 1 hr. New needles on different branchlets of the same tree could be independently injured by either O_3 or SO_2 at approximately 25 + or -5 pphm for 2 hr. Sulfur dioxide was considerably more phototoxic than O_3. Macroscopic differences in development of injury on new needles induced by both gases are discussed. No histological differences of diagnostic significance were noted between the two kinds of injury.
Source: 1

#430
Costonis, A. C. "Effects of ambient sulfur dioxide and ozone on eastern white pine in a rural environment." Phytopathology, 61(6):717-720 (June 1971).

The effects of air pollution on conifers growing on a plantation about 1.5 miles from an industrialized area was investigated with respect to specific effects of sulfur dioxide and ozone on eastern white pine. Symptoms of acute and chronic injury due to SO_2 were determined on both current and old foliage and were correlated with increases in the concentration of ambient SO_2. Concentrations of six pphm for four hours induced acute injury to new needles of field trees and adjacent potted indicator plants. Ozone concentrations did not exceed four pphm and were not correlated with injuries. Acute and chronic symptoms are described and lesion severity ratings are discussed.
Source: 1

#1034
Costonis,A.C. "Injury to eastern white pine by sulfur dioxide and ozone alone and in mixtures." Eur. J. Forest Pathol., 3(1):50-55 (1973).

Clones of eastern white pine trees selected for their sensitivity to sulfur dioxide were fumigated in a controlled environment chamber. Sulfur dioxide alone and in combination with ozone at concentrations of 5 pphm of air by volume of each gas for independent 2-hour exposures was toxic to new needles. The severest injury resulted from a discontinuous fumigation with 5 pphm O_3

and 5 pphm SO_2 for 2 hr in separate fumigations followed 24 hr later by a 2-hour exposure to a mixture of these gases, each at 5 pphm. The rapidity of lesion development and total injury to new needles were less following a single 2-hour fumigation with an O_3-SO_2 mixture than when a single 2-hour fumigation with SO_2 alone was used. Ozone and SO_2 reacted to reduce injury These plants were not injured by O_3 used alone. New needles receiving only filtered or new needles on resistant plants were not visibly affected by any treatment. Acute injury induced by the O_3-SO_2 mixture developed differently from injury induced by SO_2 alone.
Source: 1

#549
Cotrufo, C. " The sensitivity of a white pine clone to air pollution as affected by N, P, and K, nitrogen, phosphorus, potassium....Pinus strobus." Southern Forest Experiment Station. USDA For Serv. Res. Note SE (US Dept. Agric. For Serv. Southeast For Exp. Stn.) 198, 4 p., April 1974.

Potted ramets of a clone of eastern white pine (Pinus strobus L.) fertilized with factorial combinations of N, P, and K were exposed to ambient air pollution in an area where SO_2 is a major pollutant. The addition of N at all levels of P and K significantly increased needle tip necrosis and, consequently, reduced needle length. The addition of P at all levels of N and K resulted in a significant reduction in average needle injury and in a reduction in the number of affected needles over the entire tree. The ramets did not respond significantly to the addition of K or to any of the N, P, or K interactions.
Source: 2

#1951
Cowherd, C., Jr., K. Axetell, Jr., C. M. Guenther, and G. A. Jutze. "Development of emission factors for fugitive dust sources." U. S. Environmental Protection Agency, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, N. C. 27711 (June 1974). EPA-450/3-74-037.

This report presents the results of an extensive field testing program to develop emission factors for certain common sources of fugitive dust. The source categories that have been investigated are: agricultural tilling unpaved roads and air strips, heavy construction activities, and aggregate storage piles. Characterization and quantification of emissions from these sources are necessary to the development of effective control strategies so that the national air quality standards for total suspended particulates may be achieved.

Because little reliable emissions data existed for these sources prior to this study, an extensive program of field sampling was required to generate the data which would provide the basis for emission factor determination. To this end, fugitive dust sampling techniques and associated data reduction schemes were developed to quantify emissions from moving and stationary dust sources. The basic measurements consisted of isokinetic dust exposure profiles with specially designed sampling equipment, dust concentrations with conventional high-volume samplers, particle size classification with high-volume cascade impactors, deposition profiles and dust transport by saltation. A description of the measurement techniques and summaries of calculated test results are presented.

For each source type, emissions are related to meteorological and source parameters, including properties of the emitting surface and characteristics of the vehicle or implement which causes the emission. This information is used to derive correction factors which appropriately adjust basic emission factors to reflect regional differences in climate and surface properties.
Source: 8

#1153
Cox, R. A., and S. A. Penkett. "Oxidation of atmospheric SO_2 by products of the ozone-olefin reaction." Nature, 230:321-322 (1971).

Measurements of the amount of ozone in the stratosphere, troposphere, and ground level are given and formation of ozone is discussed. However, aerosol formation is the primary concern of the paper. It is stated that the reaction between ozone and SO_2 is too slow to be significant at atmospheric concentrations; however, the reaction with unsaturated hydrocarbons is comparably much more rapid. When an ozone-olefin reaction occurs, the oxidation of sulfur dioxide may result. There are two tables of data relating the varying amounts of aerosol formed by the ozone - 4-methyl -1- pentene reaction with initial SO_2 concentration and secondly the rate of aerosol formation for various olefins.
Source: 5

#1162
Cox, R. A., and S. A. Penkett. "Effect of relative humidity on the disappearance of ozone and SO_2 in contained systems." Atmospheric Environment, 6: 365-368 (1972).

The decay of sulphur dioxide and ozone concentrations has been observed in two different containers. The decay is first order in both cases indicating irreversible absorption on the walls. Relative values are considered in terms of deposition velocities (v_g) and these are shown to be very sensitive to the humidity of the system. In the case of sulphur dioxide at high humidities, v_g values are high and come very close to the maximum value for the system as measured by Thorium B disappearance. In the case of ozone, v_g is much smaller but the increase with humidity is sufficiently large to affect overall ozone concentrations in experiments simulating photochemical smog formation.
Source: 6

#175
Cox, W. J., and D. W. Rains. "Effect of lime on lead uptake by five plant species." J. Environ. Quality, 1(2):167-169 (1972).

The effect of species variation and lime treatments on lead uptake from lead-contaminated soils was examined. Lime in concentrations of 0, 2.2, and 4.4 t/ha was applied to two soils of Los Osos clay loam containing lead in the ranges of 76-112 ppm and 25-39 ppm, the lead uptake by 5 species of cereal grasses and herbs was also determined. The addition of lime did not affect the yield, but did reduce lead concentrations in the plant tops. At all times of harvest and lime rates, lead uptake values were greatest in Glycine max L., followed by Trifolium subterraneum and lesser but equal values for Zea mays L., Avena sativa L., and Triticum aestivum L.
Source: 1

#1091
Craig, D. K., and B. L. Klepper. "Design and calibration of a low speed wind tunnel for studying of foliar deposition and uptake of aerosols." Am. Ind. Hyg. Assoc. J., 36:692 (September 1975).

Interest in the interactions of airborne plutonium particles with the above-ground parts of terrestrial plants, particularly leafy surfaces, has intensified recently as a consequence of the legal requirement for environmental impact analyses of nuclear facilities. In order to conduct such studies, an experimental facility was required that would permit highly toxic radioactive aerosols to be delivered to the foliage of terrestrial plants under safe and well-characterized conditions. As far as we could determine, no such facility existed elsewhere in this country that was suitable for the planned experiments. Exposure chambers designed for plant physiological studies[1,2] or for deposition studies[3] with such shortlived isotopes as ^{131}I did not have suitable double containment for use with toxic and long-lived radioactive materials such as plutonium. We therefore designed and built a low speed windtunnel having all potentially contaminated parts contained within a glove box. This paper describes the facility, together with its testing and calibration using a ^{198}Au-labelled collodal gold aerosol.
Source: 1

#1154
Craig, H., and L. I. Gordon. "Nitrous oxide in the ocean and marine atmosphere." Geochem. Cosmochim Actu, 27:949-955 (1963).

Nitrous oxide has been found in surface and deep ocean waters of the S. Pacific. The observed concentrations are lower than expected for solubility equilibrium with concentrations previously reported in the continental atmosphere. Lower atmospheric concentrations than previous continental data have been found in N. Pacific air. These variations indicate that N_2O should be an important tracer gas for atmospheric studies.
Sources: 5

#771
Craker, L. E. "Ethylene production from ozone injured plants." Environ Pollut., 1(4):299-304 (April 1971).

In experiments to determine if ozone-injured plant tissue produces significantly larger quantities of ethylene than uninjured tissue, tobacco, tomato, and pinto bean plants were treated with ozone in a plexiglass box. After fumigation, the plants were sealed in bell jars. Differences in ethylene production between ozone treated and control plants were seen after two to four hours. These results indicate that ozone injury to plant tissues can induce ethylene production. Ethylene production appeared to be related to the extent of injury. More severe plant injury is a result of more cells being damaged by the pollutant and thus would induce more cells to evolve ethylene. These studies do not prove that injury symptoms seen in plants after ozone fumigation are due to ethylene. However, some physiological responses observed after ozone treatment have been previously reported as ethylene responses and they may be a result of induced ethylene production oxidant injury.
Source: 1

#1036
Craker, L.E. "Decline and recovery of petunia flower development from ozone stress." HortScience, 7(5):484 (October 1972).

Ozone can cause developmental changes in the inflorescence of plants. To discover if these changes are permanent, petunias were exposed to 5-7 microliter ozone for 6 hr/day, 5 days a week. Flower fresh weight and diameter decreased compared with controls growing in an ozone-free environment. Thirty-one days after the cessation of ozone treatment, the plant's new flowers had recovered to over 90% of the fresh weight and diameter of control plants.
Source: 1

#550
Craker, L.E., J.L. Berube and P.B. Fredrickson. "Community monitoring of air pollution with plants." Atmos. Environ., 8(8):845-853 (August 1974).

Oxidant air pollution injury to tobacco leaves was used as a monitoring system for demonstrating air pollution within a suburban community. Isopollutans, constructed by connecting points of equal plant leaf injury from air pollution, indicated areas within the community where levels of pollution were relatively high or low. The air pollution levels correlated visually with vehicular traffic patterns in the community.
Source: 2

#77
Craker, L. E., and W. J. Manning. "SO_2 uptake by soil fungi." Environ. Pollut., 6:309-311 (1974).

Brief report on capability and efficiency of soil fungi to remove SO_2 from soil. Bacteria and fungi were isolated from soil and grown in culture. Subsequently cultures were exposed to radioactive SO_2 and then they underwent autoradiography. The autoradiograph indicated that ^{35}S was distributed throughout entire fungal colony. Of the microorganisms tested, only fungi appeared capable of SO_2 uptake.
Source: 6

#1037
Craker, L.E., and J.S. Starbuck. "Metabolic changes associated with ozone injury of bean leaves." Can. J. Plant Sci. (Ottawa), 52:589-597 (July 1972).

Bean plants were grown in a greenhouse and exposed to ozone. Metabolic processes in primary Pinto bean leaves were altered by ozone stress; decreases in levels of ribonucleic acid (RNA) and protein, and increase in ribonuclease (RNase) and free amine groups were associated with visible oxidant injury to the leaves. Treatment of bean plants with 0.15 and 0.25 microleter/l of O_3 for 2 hr increase relative RNase activity in the leaves measured 2, 4, and 24 hr after treatment. The increase was progressive. No increased RNase activity occurred in leaves treated with 0.05 microliter/l 03. Leaves treated with o.25 microliter/l O_3 had decreases in RNA content

of leaves, while treatment with 0.05 and 0.15 microliter/1 had no significant effect. There was a progressive increase in free amine nitrogen in plants treated with 0.25 microliter/1 of O_3. Leaf tissue from plants treated with 0.05 and 0.15 microliter/1 O_3 had the same amounts of ninhydrin-sensitive groups as control plants. Protein content decreased below protein levels in control plants at 4 and 24 hr after treatment with 0.25 microliter/1 O_3 for 2 hr; there were increase in protein in 0.15 microliter/1 O_3-treated plants at 2 and 4 hr after O_3 treatment and in the 0.05 microliter/1 O_3 treated plants immediately after O_3 treatment. There were significant decreases in chlorophyll for the 0.15 and 0.25 microliter/1 treatments when measured 24 hr after treatment. There were no changes in dry weight of bean leaf at any of the sampling times for any of the O_3 concentrations. In plants treated with 0.05 microliter/1 O_3 for 2 hr there was no vibile injury; in those treated with 0.15 for 2 hr there were small white flecks on the edge of the leaves; and in those treated with 0.25 for 2 hr, there was an initial wilting followed by loss of chlorophyll in interveinal areas of the leaves 24 hr after O_3 treatment.
Source: 1

#1035
Craker, L. E., and J.S. Starbuck. "Leaf age and air pollutant susceptibility uptake of ozone and sulfur dioxide." Environ. Res. 6(1):91-94 (March 1973).

Leaf age and air pollutant susceptibility were correlated with respect to leaf uptake of ozone and sulfur dioxide. The uptake of 03 and SO2 was high in the intermediate age and low in the young and old leaves of tobacco plants. The differences in uptake agreed with the visible injury patterns, where the mature and young leaves were not injured by air pollutants but the leaves approaching maturity were necrotic and spotted.
Source: 1, 6

#1038
Crecelius, E. A., C. J. Johnson, and G. C. Hofer. "Contamination of soils near a copper smelter by arsenic, antimony and lead." Water, Air, Soil Pollut., 3(3):337-342 (Sept. 1974).

Stack dust from a large copper smelter near Tacoma, Washington has contaminated soil in the area with arsenic, antimony, and lead. Within 5 km of the smelter, 380 ppm (dry weight) arsenic, 200 ppm antimony, and 540 ppm lead were measured in the surface soil (0-3 cm). Plants grown in these soils may be affected. The consumption of plants coated with this heavy metal-rich dust may be of concern. Standard orchard leaves in the area were collected. The following mean concentrations and standard deviations were determined for orchard leaves: 10.5 + or -0.5 ppm As and 3.5 + or -0.5 ppm Sb.
Source: 1

#176
Crecelius, E. A., and D. Z. Piper. "Particulate lead contamination recorded in sedimentary cores from Lake Washington, Seattle." Environ. Sci. Technol., 7(11):1053-1055 (November 1973).

The relative contribution of lead to the environment by autos and smelter and the relative change in the overall level of Pb pollution from 1880 to the present in the Seattle area was evaluated. The lead concentration in two sediment cores from Lake Washington was analyzed by atomic absorption spectrophotometry. Lead and copper analyses of the fir needles, which represented first and second year growth only, also were measured by atomic absorption. Within these cores, the Pb concentration exhibited an increase from about 25 ppm at the 30-50 cm depth to about 400 ppm in near surface sediment. The substantial increase in Pb above 30 cm was not continuous, but exhibited a subminimum near the 17 cm depth. The concentration of 400 ppm in the surface sediment represents a 20-fold increase over that measured in the deepest sediment analyzed from these cores. Variations of Pb and Cu in fir needles of a single tree and between adjacent trees were as much as 75%. The reason for these variations have not yet been determined. The increase in Pb in the sediments parallels the increase in population of the surrounded land. The two major sources of Pb are believed to be particulate Pb from the Tacoma smelter (from 1890 to 1913) and automobile gasoline additives (from 1920 to present.)
Source: 1

#177
Crocker, T. D. "In Polk and Hillsborough Counties, Florida." Bull.At. Sci., 1965:17-19 (June 1965).

Air pollution in the citrus growing area in Polk and Hillsborough counties, Florida, is described. This area has one of the world's largest and richest phosphate deposits, and therefore a large phosphate industry grew in the area. It supplies over 75% of the nation's phosphate rock. Expanded food and fiber production in the area caused removal of most of the phosphorus in the soil used for agriculture. Therefore, fertilizers such as triple superphosphate were applied in the area. This resulted in increased fertilizer production at the phosphate plants, and thus, increased air pollution due to fluorides. Cattle in the area were affected by fluorosis, and citrus showed chlorosis due to the gaseous fluorides. Some areas generally had concentrations of 10 ppb fluorides in the air. The air pollution was worse in the winter and early spring; these months also had the greatest occurrence of cattle and citrus damage. Due to combined governmental and industrial efforrs, fluoride emissions were reduced from 33,000 pounds/day (winter of 1961-1962) to 13,000 lbs/day (winter of 1963-1964). Since 1959, air pollution control equipment costing $16 million has been added. A new, pollution-free plant costing $20 million replaced an old one. A new proposal is being considered to limit fluoride emissions further.
Source: 1

#772
Crocker, W. "Physiological Effects of Ethylene and other Unsaturated Carbon-Containing Gases." In: Growth of Plants, New York, Reinhold Publishing Corp., Chapt. 4, p. 139-171 (1948).

The effects of ethylene, acetylene, propylene, and carbon monoxide on plant development and metabolism were studied. Qualitatively, the four gases act similarly on plants; each produces the response that any other produces provided they are used in the proper concentrations. Quantitatively, they are different; the minimum effective concentration of ethylene is lower than that of acetylene and propylene, and the effective concentration of CO is higher than that of the last two. Ethylene modifies the geotropic equilibrium position of plant organs, causing declination or horizontal nutation of pea seedlings, leaf abscission, and change in root orientation. With a sensitive variety of sweet pea, using declination as the indicator, ethylene concentrations of 0.2 ppm can be detected. Using leaf epinasty of the tomato, 0.1 ppm ethylene can be detected. Leaf epinasty of the African marigold is the most sensitive test known for ethylene; it will detect 0.001 ppm ethylene in air. Ethylene causes dormant cells to enlarge and divide, forming soft, massive tissues. It induces the abscission of leaves, flowers, petals, and fruits by causing the flat cells of the abscission layer to enlarge and become spherical. Ethylene induces the decomposition of chlorophyll and is used to hasten the proper coloring of ripe citrus fruits and to bleach celery. It induces many other metabolic changes which are mainly hydrolytic, such as transformations of insoluble protopectins to soluble pectins, higher carbohydrates to soluble sugars, and proteins to polypeptides and amino acids.
Source: 1

#1843
Croessman, G. "Untersuchungen ueber Anreicherungen von Schwermetallen in Boeden mit und ohne Bearbeitung." (Studies concerning the enrichment of heavy metals in tilled and untilled soils). Staub, Reinhaltung Luft, 34(1):22-23 (January 1974).

In the neighborhood of a heavy metal emission source three plots of untilled land of three sq m were staked out at distances of 300, 600 and 900 m from the plant. The plots were located in the main wind direction. Agriculturally used land was used for comparison. Soil samples were taken at the end of the growing season for three years. The agriculturally used soil measured lower zinc concentrations at a depth of 15 cm than the untilled soil. In the top layer it was nearly half as high as that in untilled soil. This difference diminished with increasing distance from emission source. The cadmium concentration of the soil was infleunced less by air pollution than the Zn concentration. At a depth of zero to 5 cm and a distance of 300 m from the plant the highest Cd concentrations were measured in untilled soil.
Source: 1

#1103
Croke, E.J., and J.J. Roberts. "Land use as an organizational basis for regional air resource management." In: Second Int. Clean Air Cong. Proc. held at Washington, D.C., 1970, H.M. Englund and W.T. Berry (eds.), Academic Press, New York, p.1247-1255 (1971).

The use of zoning as a legal instrument for air pollution control is discussed. A proposal was made to form emission density limits to each zoning class. Within the context of this proposed system, all of the usual control techniques can be applied. A regional "airshed" becomes a physical, economic and political reality and can be managed in much the same way as a watershed area.
Source: 8

#431
Crudgington, D.R., J. Markland, and J. Vallance. "The Uptake of lead by vegetables from soil." J. Ass. Pub. Anal., 11:120-126 (Dec. 1973).

Determinations were made for the lead content of vegetables and soil in the Matlock area of Derbyshire in an effort to assess the extent of Pb uptake from the soil; soil concentrations of zinc and cadmium were also investigated. Although there was evidence of Pb in whole samples of root vegetables (difficult to wash free of soil), the peeled roots contained very little metal, and the results afforded no evidence of Pb uptake from the soil. The atmosphere was clearly a source of Pb as demonstrated by the tops of gooseberries and blackcurrants and their washings; tests on outer leaves of lettuce and brassicas also pointed to airborne Pb. A Pb-processing works was located near the test area. The Pb, Zn, and Cd concentrations for a variety of garden soils were also investigated and recorded.
Source: 1

#432
Curtis, C.R., and R.K. Howell. "Increases in peroxidase isoenzyme activity in bean leaves exposed to low doses of ozone." Phytopathology, 61(10):1306-1307 (October 1971).

Polyacrylamide gel electrophoresis of Temp bean leaf proteins, extracted from plants grown in filtered air, revealed that low doses of ozone (20-25 pphm for 90-180 min) increased the activity of many peroxidase isoenzymes. Symptomless leaves previously exposed to ozone showed a similar increase in activity, but not as much as in leaves exhibiting definite symptoms of ozone injury.
Source: 8

#43

Czaja, A. "On the problem of the effect of cement dust on plants." Staub (Dust) 22(6):228-232 (1962).

Author describes fate of cement dust when it leaves factory chimneys. First, it is subject to aerosol formation and is deposited as an aerosol on plants under weather conditions which lead to setting of the hydration - ready dust and to crust formation with deformation of the cell surfaces. Lime hydrate is released during setting process and is a very strong caustic poison which penetrates conifer needle stoma or upper epidermis of leaves and damages living content of leaf cells. This penetration can be established chemically by means of tannin reaction.
Source: 1

#99

Dadlman, R. C., S. I. Auerbach, P. B. Dunaway. "Behavior of ^{137}Cs - tagged particles in a fescue meadow." (Reprint from Environmental Contamination by Radioactive Materials, International Atomic Energy Agency, Vienna, 1969). Oak Ridge National Lab., Health Physics Division, Radiation Ecology Section, pp. 153-165. SM-117/72.

Enclosures of tall fescue (Festuca arundinacea), 0.01 ha in area, were contaminated at the rate of 25 g/ft^2 using artificial fallout (^{137}Cs fused to 88-177 μm silica sand, ~100 μCi/g, 15% leachable in water) to study the effects of close-in fallout on a grass system. Investigations of radiation effects, intercompartmental cycling of radiocaesium and secondary movements of the simulant particles in soil and litter have been in progress since midsummer, 1968. Plant community response (yield, seed production and species composition), small mammal physiology (haemopoietic and gut effects) and insect population dynamics are being studied following exposure to chronic, internal-external, beta-gamma radiation. Sand particles intercepted by grass blades were readily dislodged by light wind, and maximum retention time was approximately 10 days. The simulant was readily trapped in the leaf axils where it remained for 4 weeks until washed off by rain. There was significant transfer (15%) of ^{137}Cs from simulant to vegetation. Vacuum and brush cleaned vegetation initially contained 1.32 μCi/g (living parts) and 4.62 μCi/g (dead parts).

Early incorporation into foliage was largely by contact assimilation because appreciable uptake had occurred before the simulant had reached the soil. Two loss rates were evident in the subsequent decrease of ^{137}Cs in living foliage. The fast component, which began 8 days after contamination and continued for 4 weeks, was described by the linear regression $Y = 1.64 - 0.04X$ where Y and X are $\mu Ci\ ^{137}Cs/g$ foliage and days, respectively. The slower loss rate commenced 4 weeks after contamination and its regression was $Y = 0.61 - 0.003X$.

Only 0.12 mCi of ^{137}Cs (0.006%) of that present) was carried from the tagged areas in one runoff event. This agreed remarkably well with that predicted from a simple model based on characteristics of simulant and soil, and on rainfall-runoff relationships.
Source: 7

#434

Daessler, H.G. "Die Wirkung der Exhalate von Grosskraftwerken auf die Vegetation." (The action of superpower station emissions on plants). Text in German. Luft. Kaeltetech, 6:250-252 (1967).

Sulfur dioxide and dust emissions for exceeding maximum allowable concentrations can be observed at distances of several kilometers from superpower stations. The degree of atmospheric contamination depends primarily on the boiler unit and on the quality of the raw brown charcoal fuel. More than 1000 tons of SO_2 are emitted daily in the Leuna-Halle-Bitterfeld-Dessau industrial area of the German Democratic Republic. Damage to coniferous forests causes enormous economic losses along with decreased vital capacity of the surviving trees and alterations of the ground flora and soil composition. Decades of dust emissions have led to alkalinization of the humus layer, and coniferous areas will have to be replaced by deciduous cultures to maintain part of the forest area. Experiments performed with nitrogen and potassium fertilizers suggest that part of the coniferous areas can be saved by intense fertilizer treatment where the orographic factor is favorable. Certain genetically fume-resistant species such as Pinus nigra or Pinus peuce should be cultivated to substitute the less resistant Pinus silvestris. However, no attempts to restore a forested environment can succeed without effective control measures to decrease the industrial emissions.
Source: 1

#1039

Daessler, H. G. "Vegetationsschaeden als Folge der Luftverschmutzung." (Plant damage from air pollution). Text in German. Wiss. Z. Tech.Univ. Dresden, 20(4):1171-1173 (1971).

The problem of air pollution-induced plant damage in East Germany is outlined. Sulfur dioxide causes most of the damage in forestry and agriculture, followed by hydrofluoric acid and silicon tetrafluoride. Dust and soot emissions are less hazardous for forests, while they may cause damage to fruits and vegetables and unfavorably modify soil properties. Arsenic, lead, copper, and zinc emissions are especially harmful since they may result in reduced crops. Invisible physiological, chronic, and acute plant damage due to pollution are distinguished. Exposures over a short time to high pollutant concentration are generally more hazardous than long-term exposures to low concentrations. The total forest damage area in East Germany is estimated at 220,000 ha. Pollution induced damages of barley and flax, as well as livestock damages due to the consumption of contaminated forage have occurred repeatedly. As the proportion of fossil fuels among the energy sources steadily increases, no decrease in the SO_2 level is expected. There are no effective means for controlling SO_2 emissions, and the construction of high stacks constitutes no real solution to the emission problem.
Source: 1

#322
Daessler, H.G. "The effect of hydrogen fluoride and cryolite dust upon plants and animals near a hydrogen fluoride factory." Fluoride, 4(1):21-24 (Jan 1971).

Some of the findings obtained from 11 test stations situated near a hydrofluoric acid factory are reviewed. Studies were conducted on forestry, agricultural, and horticultural plantings in the emission area. In the immediate vicinity of the factory, HF induced necrotic lessions on vegetation and fluoride accumulation in the folliage of fruit trees. The leaves of fruit trees showed necroses on the side of the plants facing the factory. The margins of leafy plants reached fluoride values of up to 80 mg in dry, hot weather. At a 6 km distance, necrotic areas were found on fruit without visible damage to the foliage, particularly in pears, sweet cherries, apples, plums, and tomatoes. Fruit development decreased when HF levels were high at blossoming time. Only the fruit of pears is sensitive; the leaves and fruit of plums are equally susceptible to damage. Resistant plants include sour cherries, winter rape, sugar beets, potatoes, cabbage, asters, and roses. Results of fumigation experiments showed that although most evergreens, walnut, and maple trees should not be considered for cultivation near fluoride pollution, field corn, common oak, and lilac can be planted. Forage near the factory contained 76-120 mg fluoride/100. This caused reduced milk production, yellow stains on teeth, motor disorders, and bone changes in dairy cows. Bee populations were also affected. A decrease in fluoride pollution was accomplished by the installation of control equipment.
Source: 1

#1040
Daessler, H.G. "Vegetationsschaeden als Folge der Luftverschmutzung." (Vegetation damage as consequence of air pollution). Text in German. Wiss. Z. Tech. Univ. Dresden, 20(4):1171-1173 (1972).

In the German Democratic Republic about 10 to 15 million tons of fly ash are emitted each year, as well as 2.5 million tons of sulfur dioxide. In the Leipzig-Altenburg area the daily SO_2 emissions amount to about 1400 tons. A concentration of 0.2 mg SO_2/cu m air damages vegetation. Various stages of injuries must be distinguished. Functional disturbances in the assimilation organs are not visible. Chronic damages are accompanied by a drop of the harvest yield. Acute injuries are indicated by heavy necrosis. The largest area of injured forest is the industrial center around Halle-Leipzig and Dessau. Constant exposure to SO_2 concentrations caused extensive injuries of pines in the Duebener Heide. The injured forest spans 60,000 hectars. Another injured forest stretched from the central and Eastern Erzgebirge to the Elbsandsteingebirge. This area spans 15,000 hectars. Moreover, forest injuries were also observed in the industrial area between Aue, Zwickau, and Karl-Marx Stadt. The forest in the Werra and Unstrut area suffers from emissions by the potassium injury. The injuries in the forest around Cottous have worsened. The German Democratic Republic has 220,000 hectars of emission injured forests, of which 30,000 hectares are so heavily injured that no coniferous trees will grow any more. The major effort for reducing the emissions must come from the industry. They must make greater use of available cleaning systems. Forestry can contribute only by planting more resistant species.
Source: 1

#1041

Daessler, H.G. "Zur Toxizitaet von Fluorverbindungen. Fluorschaeden in der Land und Forstwirtschaft." (The toxicity of fluorine compounds, fluorine injuries in agriculture and forestry). Text in German. In: Technik und Umweltschutz Luft - Wasser - Boden - Laerm, Luftverunreinigung bestimmter Gebiete und technologische Verfahren zur Emissionsverminderung. Leipzig, VEB Deutscher Verlag fuer Grundstoffindustrie, 5:52-57 (1974).

Sources for fluorine containing emissions are hydrofluoric acid plants, aluminum plants, the glass industry, producers of phosphate containing fertilizers, brick kilns, and the ceramic industry. Little attention has been paid in the past to fluorine containing coal whose fluorine content ranges from 2 to 3 mg/kg referred to dry coal. The maximum allowable immission concentration for fluorine in the German Democratic Republic is 10 micrograms/cu m air. A review of the effects of fluorine immissions on agriculture, horticulture, and forestry is given. The fluorine content in plants from immission free areas was determined to range from 0.2 to 2.0 mg/100 g dry substance. Agriculture and forestry strives to reduce fluorine injuries by selecting fluorine resistant species. For this, extensive fumigation experiments in the field and in potted cultures are needed. Exposure to low hydrogen fluoride concentrations and simultaneous measurement of carbon dioxide metabolism supply information on yield reductions and on any possible lowering of the nutrient content. Main emphasis must be placed, however, on reducing the emissions which can be achieved by absorption systems operating with water, diluted caustic soda, and sodium carbonate solution.
Source: 1

#433

Daessler, H.G., and S.Boertitz. "Zur Wirkungsweise von Luftverunreinigungen auf landwirtschaftliche Erzeugnisse." (Effects of air pollutants on agricultural products). Text in German. Biol. Zentraibl, 90(5):611-619 (September-October 1971).

With the aid of simplified graphs, the specific effects of sulfur dioxide fluorides, and indifferent and toxic (lead, zinc, and arsenic containing) dusts on agricultural plants in the German Democratic Republic are shown. Continuous and long-term exposure to low SO_2 concentrations impair the photosynthesis (carbon dioxide assimilation), which in turn affects the quantity and quality of plant products. Most characteristic is the reduction of crop yield. Moreover, the SO_2 intake raises the sulfate level in plants. Relatively high SO_2 concentrations cause the death of cells, photosynthesis does not take place any more in necrotic tissue. Exposure to fluorine-containing emissions and to dusts leads to an accumulation of these pollutants in the plants to an extent which might be harmful to animals. Exposure of plants to non-toxic dusts such as fly ash and soot causes considerable changes of the plant metabolism. Toxic dusts inactivate ferments and retard root growth.
Source: 1

#1042

Daessler, H.G., H. Ranft, and K.H. Rehn. "Zur Widerstandsfaehigkeit von Gehoelzen gegenueber Fluorverbindungen und Schwefeldioxid." (The susceptibility of woody plants exposed to fluorine compounds and SO2). Flora (Jena), 161(3):289-302 (1972).

The susceptibility of 80 woody plant species to fluorine compounds was studied in fumigation chambers and in a test area around a major fluorine emission source, and the results are compared with those of previous sulfur dioxide toxicity tests. The hydrofluoric concentrations in the chambers ranged from 0.3 to 0.5 mg/cu m. Juglans regia, Vitis vinifera, Pinus silvestris, Berberis vulgaris, Rhododendron japonica, Picea abies, and Larix decidua were the most susceptible species to HF. Taxus baccata, Tilia cordata, Alnus incana, Ribes sanguineum, Salix elaeagnus, Populus regenerata Harff, Carpinus betulus, Pinus Strobus, Pinus nigra austr., Potentilla fruticosa arb., Castanea sativa, Lonicera tatarica, Larix leptolepsis, and Picea pungens were classed as fluorine-susceptible, while such species as Pinus montana, P. controta, Cornus alba sib., Prunus cerasifera Piss., Ulmus campestre, Alnus glutinosa, Buxus sempervirens, Pinus peuce, Syringa japonica, Acer Negundo, Robina pseudoacacia, Ailanthus altissima, Fagus silvaticus, Populus candicans, Fraxinus excelsior, Humulus lupoloe, Crategus monogyna, Salix aquatica, Spiraea vonhouttes, Platanus aceerifolia, Quercus borealis, Betula pendula, Prutnen serotina, Virburnum carlesii, and Hydrangea pan were moderately susceptible to HF. Juniperus squamata m., Labornum anagyrodies, Virburnum Lantana, Tamrix tetr., Spiraeabum, A. Wat., Elaeagnus angustifolia, Weigelia hybr., Ruhn Rosa rugosa, and Synringa vulgaris were relatively resistant. Very high resistance of such species as Acer campestre, Acer platanoides, Evonymus europaea, Philadelphus coronarium, Quercus robur, and Sambucus racemosa was determined. Intercostal necroses, and necroses on the leaves and needles were the common symptoms of fluorine damage. The overwhelming majority of the species investigated had identical or comparable susceptibility to both fluorine and SO_2.
Source: 1

#1581

Daines, R. H. "Sulfur dioxide and plant response." (Presented at the Symposium on Air Quality Criteria, June 5, 1968.) J. Occupational Med., 10(9):516-534 (September 1968).

Based on a review of data from the Boyce Thompson Institute and elsewhere, it is concluded that the maximum allowable concentration for SO_2 should be based on plant response, concentrations that produce visible injury being judged as too high. Although the incidence of severe plant damage from SO_2 fumigations near industrial plants has decreased markedly since the application of controls, some of the most sensitive plants still show such injuries, and the reduced SO2 concentrations produced by many widespread, relatively small emitters, largely involving the combustion of fossil fuels, may be responsible for some decreases in crop yields. The response of plants to SO_2 is affected not only by the SO2 concentration and duration of exposure, but also by the light intensity, temperature, time of day, season of the year, wind speed, humidity, soil moisture, age and condition of the plant, and other factors. Levels of 0.1-0.25 ppm have produced no significant injury in alfalfa or wheat grown in soil under normal conditions, and levels of 0.51 ppm or higher are needed to produce permanent damage to photosynthesis and respiration in wheat and alfalfa, although lower concentrations (e. g., 0.348 ppm) decrease the rate of photosynthesis during the time of actual exposure).
Source: 1

#178

Daines, R. H., I. Leone, and E. Brennan. "The effect of fluorine on plants as determined by soil nutrition and fumigation studies." Air Pollut., Proc. U. S. Tech. Conf., Washington, D. C., 97-105 (May 3-5, 1950).

Results of experimental studies of fluorine toxicity and mechanisms or action in various plant species are reported, indicating that plants absorb F from both the atmosphere and soil, thereby accumulating the abnormally high F content that causes development of typical toxic symptoms. A means of distinguishing between F from the air or from the substrate was determined, since atmospheric F results in a high leaf and low root F content, whereas soil F causes a high leaf and even higher root content. Plant species vary in their threshold concentrations that cause visible injury, in capacity for uptake of F, and in the relation between F content and the extent of injury. Plants grown with optimum supplies of nitrogen, calcium, and phosphorous are more susceptible to F injury from the soil and, to a less extent, from the atmosphere than plants with unbalanced nutrition. As the soil pH increases, F toxicity and the amount of F absorbed are minimized. High atmospheric humidity, turbidity of the plant, and wetting of the plant surfaces are conducive to a greater degree of injury and F absorption. A loss of F in plant leaves following an exposure to F in solution or in the atmosphere is being studied.
Source: 1

#179

Darley, E.F. "Studies on the effect of cement-kiln dust on vegetation." J. Air Pollution Control Assoc., 16(3):145-50 (March 1966).

Most of the recent work on the effects of cement-kiln dust has been confined to Germany and results differ considerably. There appears to be little doubt that naturally deposited dust from certain cement plants is responsible for leaf injury to deciduous and coniferous species and occasionally for death of the latter. Injury results from the combination of a relatively thick crust deposit and the toxicity of alkaline solutions formed when dusts are deposited in the presence of free moisture. The results of several hand-dusted field experiments, however, are not so conclusive; dusts are reported as either harmful, harmless, or even indirectly beneficial. In the present laboratory investigation, the comparison of CO2 exchange in the leaf between dusted and nondusted leaves, as well as occurrence of obvious tissue damage, were used as the criteria of dust effects in short term experiments. The results demonstrated that the finer particles of certain cement-kiln dusts collected from electrostatic precipitators do interfere with CO2 exchange and in some cases cause considerable leaf injury. The results further suggest that calcium content alone may not be the only indicator of whether a dust might be injurious, and that much more needs to be known about the effects of the interaction of chemical composition, particle size, and deposition rate.
Source: 1

#435
Darley, E. F. "The role of photochemical air pollution on vegetation." Air Pollution Proc. First European Cong. Influence Air Pollution, Plants Animals, Wageningen Netherlands, Pg. 137-142 (April 22-27, 1968).

Photochemical air pollution, a relatively new phenomenon first described near Los Angeles, is now also present in other parts of the world. It results from reactions in the atmosphere between nitrogen oxides and certain hydrocarbons, principally the unsaturated or olefinic hydrocarbons. Automobiles are the principal source of these compounds. The phytotoxic products of these photochemical reactions are peroxyacetyl nitrate ozone, and nitrogen dioxide. Injury symptoms caused by PAN and ozone are characteristic and different. Plant injury by PAN is confined to the lower leaf surface and appears as silvering, bronzing, or metalic sheen. Some of the best indicators of PAN damage are leafy vegetables and petunias. The characteristic injury symptom of ozone is a stippling, mottling or chlorosis confined to the upper leaf surface. Concentration of PAN and ozone below those producing visible symptoms may cause a reduction in plant growth. Nitrogen dioxide does not cause symptoms at ambient concentrations, but may result in growth reductions. Losses from photochemical air pollution are a significant factor in agricultural production. In California, the annual direct economic loss may be $10 to $12 million; the indirect loss due to growth retardation, delayed maturity reduced yields, and impaired quality may be ten times that.
Source: 1

#1043
Darley, E. F. "Vegetation Damage From Air Pollution." In: Combustion-Generated Air Pollution. A Short Course on Combustion-Generated Air Pollution held at the University of California, Berkeley, September 22-26, 1969. Ernest S. Starkman (ed.), New York-London, Plenum Press, p. 245-255 (1971).

Principle air pollutants that adversely affect growth and development of vegetation are discussed. The typical injury symptom from peroxyacyl nitrates is a silvering, glazing, or otherwise metallic sheen on the lower surface of affected leaves. The symptoms from various PANs appear to be the same, but as the carbon number of the molecule increases so does the relative toxicity. Injury from ozone results in stippling, mottling, or a chlorosis that is confined to the upper surface of the leaf. Ozone has a similar effect on growth and cell wall metabolism compared to PAN, but, whereas short periods of darkness before, during, and after exposure prevent PAN damage, this is not so with ozone. The hydrocarbon ethylene affects flower production of ornamental species; the dry sepal injury to orchids is a prime example. The chief symptom of acute injury from sulfur dioxide is a white to tan bleaching of leaf tissues; the injury goes clear through the leaf and is not confined to one or the other surface. High concentrations of nitrogen dioxide produce similar effects, although recent experiments with a variety of plants exposed to nitrogen dioxide have demonstrated that concentrations of a few tenths ppm for several weeks can reduce growth as much as 35%. The typical symptomology of hydrogen fluoride poisoning is a necrosis of the margin of dicotyledonous of broad-leaved plants and of the tips of monocotyledonous, parallel-veined plants. Certain cement kiln dusts have been shown to be toxic to plant leaves when deposited in the presence of free moisture. Dry dusts apparently do not have this affect but may interfere with the normal photosynthesis by the fact that they reduce th light reaching the leaf.
Source: 1

#1961

Darley, E. F., H. H. Biswell, G. Miller, and J. Goss. "Air pollution from forest and agricultural burning." Preprint, Combustion Institute, Western States Section, 10 p. 1972. (Presented at the Combustion Institute, Western States Section, Spring Meeting, Seattle, Wash., April 24-25, 1972, Paper WSC1 72-11.)

The increasing use of prescribed fire in forest management and the continuing burning of agricultural crop residues creates problems in air pollution. Large scale laboratory type experiments and field trials are being conducted to evaluate yields of pollutant gases and particulates and methods for altering these emissions by fuel types were burned under a cone shaped tower which simulates open burning but permits continuous analysts of total hydrocarbons, carbon dioxide, carbon monoxide, and oxygen. Grab samples were taken at two or more intervals during the fire for analysis of nitrogen dioxide and individual hydrocarbons. Particulates were collected isokinetically throughout the fires. Rate of weight loss of the burning fuel, temperature and airflow were also recorded. From these data, yield of pollutant in lbs/ton of fuel burned were calculated. Field plots of forest floor fuels and straw and stubble from cereal crops were also burned. A ten-foot tower instrumented for temperature, carbon dioxide and particulate was set up in plots in grain fields and it sampled the smoke as fires burned past the tower. A modified version of Boubel's portable particulate sampler, which also provides for gas sampling, was evaluated for possible use in forest plots. For both laboratory and field fires, variables presently being tested for effect on pollution are fuel type, loading, moisture level, methods of ignition, piled versus spread fuels, and head versus back fires.
Source: 1

#1044

Das, G., and V. C. Runeckles. "Effect of bisulfite on metabolic development in synchronous chlorella pyrenoidosa." Environ. Res., 7(3):353-362 (June 1974).

The effects of bisulfite on the metabolic development of the algae Chlorella pyrenoidoda grown in synchronous culture were investigated. Chlorophyll, protein, ribonucleic acid (RNA), and desoxyribonucleic acid (DNA) decreased with the decline in cell population, as HSO_3 negative ion concentration was increased. Biochemical analysis after treatment showed a differential change in the levels of chlorophyll, protein, RNA, and DNA, when expressed as percentages of the cell dry weight. The content of chlorophyll b increased while chlorophyll a decreased gradually with increases in HSO_3 negative ion. The amounts of protein and RNA per unit dry weight remained constant, but DNA levels were markedly reduced. With the exception of iron, the levels of nutrient elements within the cells increased with increasing HSO_3 negative ion concentration. The relative increases were most marked with potassium, magnesium, calcium, copper, and sodium. The HSO_3 negative ion adversely affects cell development by impairing DNA synthesis.
Source: 1

#1045
Date, N., T. Sawada, T. Yoneyama, and S. Motohashi. "Tonai koen jumoku no okishidanto higai to dojo no rikagakuteki tokucho." (Oxidant damage of trees in metropolitan parks and the physiochemical properties of soil therein). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, 562-572 (March 1974).

A survey was made of plant vigor of trees and of soil cross section and chemical analysis. In comparison between parks, the average concentration of oxidant affected the plant vigor and the effect of soil condition was not clear. However, in comparison of individual trees within the parks there were cases in which the effect of soil condition was recognized. In Ueno Park where the paving is extensive and the trees do not have enough space for rooting, the nutritious substances represented by electric conductivity affected the vigor of zelkova trees. In other parks where trees had enough space for rooting, soil condition did not affect the vigor of the trees except where the soil properties did not fit zelkova trees because of low and wet alluvial soil therein.
Source: 1

#1980
Davis, D.D., and J.B. Coppolino. "Relationship between age and ozone sensitivity of current needles of ponderosa pine." Plant Disease Reptr., 58(7):660-663 (July 1974).

Ponderosa pine seedlings are exposed in a controlled chamber to acute doses of ozone at weekly intervals throughout the summer in an investigation of the relationship between age and ozone sensitivity. The needles exhibit maximum sensitivity during the third to ninth week of age, with chlorotic mottle being the most common symptom. Tip necrosis and banding are also observed to a lesser degree. The chlorotic mottle occurs on the tips of immature needles and is widespread on mature needles. Banding occasionally occurs near the tips of young needles and is located progressively toward the needle base as the needle length increases. Sensitivity to ozone decreases as the needles mature and approach their terminal length of 100-120 mm.
Source: 1

#436
Davidson, H. "Pine mortality along Michigan highways." HortScience, 5(1): 12-13 (February 1970).

During the spring and fall of 1966, 3149 pine trees were planted along Michigan highways as part of a highway beautification plan. A 1969 survey of selected plantings indicated that approximately 40% of the pines were dead or in very poor physiological condition. Most of the plants in poor condition were located near the edge of the highway and were in the splash or drift zone. These plants, particularly white and red pine, exhibited considerable needle desiccation as a result of calcium chloride solutions that drifted onto the needles following the application of salt to the highway. Other factors contributing to the loss of trees were the planting of trees with poorly developed root systems and the pruning of fall-planted trees, which resulted in the loss of terminal buds. Loss of trees through salt deposition on crowns can be reduced by planting only species tolerant to salt-injury such as Austrian pine, Scots pine, and spruce.
Source: 1

#437

Davidsson, I. "Vaxandi fluormengun." (Increased fluorine pollution). Text in Icelandic. Freyr, 67(7/8):167-168 (April 1971).

General problems of air pollution are outlined with speical regard to fluorine. Damage caused by fluorine was observed in coniferous forests near Ragnars Peturssonar during the second part of the vegetation period. Red to brown spots appeared on the needles in August. In November, whitening of the needle edges was observed, which was followed by necrosis. Fluorine concentrations up to 193 ppm were measured in this area. Coniferous forests were damaged by fluorine-bearing dusts at concentrations of 10-20 ppm in Norway.
Source: 1

#1046

Davies, B. E. "Occurrence and distribution of lead and other metals in two areas of unusual disease incidence in Britain." Commission of the European Communities, Luxembourg, and Environmental Protection Agency, Washington, D. C. Proc. Int. Symp. Environ Health Aspects Lead, Amsterdam, Netherlands, 1972, EUR 5004 d-e-f, p. 125-134, May 1973. (October 2-6).

The occurrence of lead, zinc, copper, and cadmium in the soil radishes, and water of two metal mining areas of Britain, namely, Cardiganshire and the Tamar Valley, was investigated. Cancer and other diseases are unusually prevalent in those areas. The total and plant-available metals are enriched in soils of the mineralized zones, and Pb is unusually higher in the polluted soils. Enhanced amounts of heavy metals are entering the food chain through vegetables and drinking water but the significance of this is uncertain.
Source; 1

#1071

Davies, C.N. "Deposition from moving aerosols." In: Aerosol Sci., C.N. Davies (ed). Academic Press, New York, pp. 393-446 (1966).

In this chapter the deposition of particles is considered which originates from sedimentation, molecular and turbulent diffusion and impingement from moving air. Various effects, such as thermophoresis, diffusiophoresis and electric mobility, which are important for fine particles in special apparatus and in air at rest, are unimportant in comparison with those due to the weight of larger particles which are swept along by a rapid air current. Air movement is considered primarily in enclosures but also to some extent in the open atmosphere.

Four regimes of particle motion can be distinguished: (i) Particles move with the air stream: small particles, low rate of flow; (ii) Particles settle at an appreciable speed but have negligible inertia: low rate of flow; (iii) Particles have negligible settling speed but appreciable inertia: small particles; and (iv) Particle settling speed and inertia have to be taken account of.
Source: 5

#291
Davies, C. N. "Particles in the atmosphere - natural and man-made." Atmos. Environ., 8(11):1069-1079 (November 1974).

The existence of natural and man-made particles in the atmosphere is reviewed, with particular emphasis on Aitken nuclei, particles less than 0.1 micron in radius which serve as condensation nuclei for droplet growth. Studies of Aitken nuclei generaion in the atmosphere show that only about 15% of these atmospheric particulates are from man-made sources (domestic fuel combustion, industrial effluents, motor vehicle exhaust). Aitken nuclei are produced both directly and indirectly through photochemical gas to particle conversion, with concentrations diminishing at night and during windy weather. Small nuclei formed during the daytime by photochemical action are lost by coagulation with larger particles. Aitken nuclei of natural origin (e. g., volcanoes, forests, and agricultural areas) appear to extend to much greater altitudes than the man-made coarse particles, so that the optical effects of the latter are predominantly within a km above ground level. This implies that the removal of the coarser, man-made particles by natural processes is more efficient than it is for fine Aitken nuclei.
Source: 1

#275
Davies, R., D. K. Werle, and W. J. Wnek. "Semimicron separation and data." IIT Research Inst., Chicago, Ill., Air Force Contract F33657-71-C-0859, Proj. VT/1414/RDE/ASD, ARPA Order 1702, Program Code 1F10, IITRI-C6239-A005-1, 363 p. (Oct. 31, 1971).

The science involved in the separation of submicron particles from a collected sample of atmospheric aerosol is very complex. It involves many facets of the basic sciences, each of which has an equally important role in the separation process. The types of forces and bonds that cause adhesion of separation of particles to and from surfaces, or to each other, are mechanical. Van der Waals, electrical, electrostatic, capillary, electrical double layer, covalent, ionic, metallic, and hydrogen. Aerosols present in the atmosphere are composed of a wide variety of constituents from many sources, both natural and anthropogenic. On a worldwide production basis, it is estimated that 1.6 billion tons of particles below 5 micron in diameter are put into the atmosphere annually, 1/3 of which are converted sulfates, with lesser amounts of converted nitrates, hydrocarbons and sooty combustion products; and only a small proportion is man-made. A large part comes from mineral and organic particles raised by the wind, ocean spray, wave crests, and photochemical and chemical reactions. The adhesion of atmospheric particles, dispersion, turbidity, pH, electrical conductivity, particle size and shape, surface active agents, and mathematical models of adhesion and agglomeration are also discussed.
Source: 1

#1048
Davis, C. R. "Sulfur dioxide fumigation of soybeans: effect on yield." J. Air Pollution Control Assoc., 22(12):964-966 (December 1972).

The influence of sulfur dioxide fumigation of soybean plants on yield was determined by a 3-year experiment on 485 plots of soybeans. Single fumigations of SO_2 with concentrations varying from 0.5 to 6 ppm were applied to 10 different stages of growth in 1968-1969 and seven stages of growth in 1970. A linear relationship existed between the percent of leaf area destroyed and the percent crop loss, with a significant regression coefficient of b equals 0.659, or 2/3 of 1% crop loss for each percent of area destroyed. No definite significant stage of growth effect was found and no treatment effects were significant for the early stages of growth from the three leaf to the 15 leaf stage, nor was there any loss in yield without visible leaf injury.
Source: 1

#773
Davis, D. D. "Air pollution and southern forests." Forest Farmer, 29(10): 6-7 (October 18 1970).

The most common pollutants capable of causing injury to forest trees include sulfur dioxide, fluoride compounds, and oxidants such as ozone. A major source of SO_2 is the burning of coal, petroleum or gas; petroleum refining, smelting and refining of ores, and the utilization or manufacturing of sulfur containing compounds may also produce SO_2. Common sources of fluorides include petroleum refineries, aluminum reduction smelters, and steel manufacturing plants. In the South, a major source is phosphate fertilizer plants. Concentrations of ozone high enough to cause plant injury may result from thunderstorm turbulence which brings oxidants down from the upper stratosphere. Compounds emitted from automobiles and industries react chemically in the air under the influence of sunlight, yielding large quantities of oxidants. Topographic features, such as the large mountain ridges typical of areas of Kentucky, North Carolina, Tennessee and Virginia, help in trapping these pollutants. Acute injury to conifer needles is usually seen as death and browning of the needle tips or the entire needle, while chronic injury is often seen as a yellowing, dwarfing, and premature shedding of the needles. Chronic O_3 injury often causes a mottled appearance to the needle. Some differences among SO_2, hydrogen fluoride, and O_3 injury to broadleaved plants are cited. Such factors as leaf age, environmental conditions, length of exposure time, herbicides, insects and fertilizers also may influence symptom development. It is likely, too, that air pollution is responsible for secondary effects, such as predisposing trees to attack by those insects or fungi which are more aggressive on weakened trees.
Source: 1

#774

Davis, D. D. "The influence of ozone on conifers." Pennsylvania State Univ. Center for Air Environment Studies, University Park. Pub. 158-70. 95 p. (March 1970).

The relative susceptibility of coniferous species commonly found in the northeastern United States to ozone is investigated. The influence of plant and needle age and environmental factors on the sensitivity of a species to ozone is explored. Needles are injured by 25 pphm 03 for 2 hr; they reach maximum sensitivity at 3-5 weeks of age, and become resistant at 16 weeks. The relationship of relative humidity,temperature and light exposure to injury is determined. Young needles are injured most severely at the tips, while older ones show most injury at the base. Chlorotic mottle and tip or needle necrosis are the most common symptoms on the secondary needles of the various conifers. It is important that the influence of 03 on plants be considered in the establishment of air quality standards.
Source: 1

#64

Davis, D. D. "A literature review regarding the ability of woody plants to remove SO_2 and photochemical oxidants from the atmosphere." Order #P5J10 397-J. Part II. EPA 30 pp. (May 31 1975).

Some controversy exists regarding the efficiency of woody plants in removing air pollutants from the atmosphere. However, plants apparently can cleanse the air of pollutants at lower concentrations, but not necessarily at higher levels. Maximum uptake is achieved by well watered, actively growing plants. Uptake rates are influenced by season, time-of-day, nutrient status, plant or leaf age, and environmental conditions. Highly reactive pollutants such as ozone are also passively broken down upon contact with plant biomass. Oxides of nitrogen and PAN are not absorbed as actively as sulfur dioxide and ozone. Large trees also aid in dispersing and diluting air pollutants.
Source: 8

#438

Davis, D.D. and F.A. Wood. "The relative susceptibility of eighteen coniferous species to ozone." Phytopathology, 62(1):14-19 (Jan. 1972).

Eighteen species of 2 to 6 year old coniferous tree seedlings were exposed to 10 pphm ozone for 8 hrs or to 25 pphm 03 for 4-8 hrs. Virginia pine, jack pine, European larch, Austrian pine, Scotch pine, eastern white pine, eastern hemlock, Japanese larch, and pitch pine were susceptible. Arborvitae, balsam fir, Douglas fir, white fir, red pine, Black Hills spruce were resistant to the highest dose. The incidence of sensitive plants within susceptible species populations ranged from 6-69% . Variable symptom response was observed in different species among individual plants of the same species, and among different branches and needles of the same plant. Chlorotic mottle and tip necrosis or complete needle necrosis were the most commonly observed symptoms. Susceptible species were sensitive from the 4th through the 13th week after budbreak. Seedlings in the dormant condition were resistant.
Source:1

#1047
Davis, D. R., and C.E. Dean. "Low-level tropospheric ozone." Monthly Weather Rev., 94(3):179-182 (March 1966).

Non-industrially produced ozone is identified as the cause of damage to tobacco crops in the contiguous area of northern Florida and southern Georgia. The ozone is believed to be stratospheric in origin, having been transported to the lower troposphere by an extratropical storm. The damage was estimated at $284,000, affecting 800 acres or one seventh of the area crop. Tobacco leaves are most susceptible to this type of damage at one stage of development. Late planting and difference in varieties grown were the primary reasons that the damage was not significant on the remainder of the acerage devoted to tobacco. The normal ozone concentration for the area is 0-4 parts per hundred million (pphm) by volume. The concentration of 9 pphm was the first occurrence sufficiently high to damage the tobacco materially. Over the years, similar damage has been reported to tomatoes and other crops in the area.
Source: 1

#1050
Davis, D.R., and C.E. Dean. "Agricultural requirements for atmospheric ozone measurements." Preprint, (Presented at the Technical Conference on Observations and Measurements of Atmospheric Pollution, Helsinki, Finland, July 30-August 4, 1973.) Preprint, 9 p.(1973).

An ozone-monitoring program and advisory service which was established to serve the needs of agricultural interests of north Florida and south Georgia is discussed. The program has been operational for 10 years. The project studied meteorological conditions which contribute to high ozone concentrations, correlated the outbreaks of weather fleck with ozone concentrations, and developed a procedure for predicting increases in ozone concentrations and weather fleck outbreaks on tobacco. The results of ozone measurements from 1963 to 1973 are summarized. Seasonal variations, direct movement of stratospheric ozone, indirect ozone movement from the primary source region, low-level photochemically produced ozone, correlation of plant damage with ozone concentrations, and a procedure for forecasting ozone plant damage are discussed.
Source: 1

#552
Davison, A.W., A.W. Rand, and W.B. Betts. "Measurement of atmospheric fluoride concentrations in urban areas." Environ. Pollu., 5(1):23-33 (July 1973).

Coal and shale are recognized sources of fluoride pollution in the United Kingdom, but little is known about ground level concentrations in urban coal-burning areas. A high-volume sampler powered by a portable generator was tested and used to measure fluorides in local mining villages. Modal concentrations were < 0.05 and about 0.3 $\mu gF/m^3$ at rural and urban sites, respectively. Concentrations were locally very high near burning pit heaps. Partition of the fluoride using a citric acid impregnated pre-filter showed that most was in gaseous, and therefore phytotoxic, form. It is suggested that fluoride concentrations from burning coal could be sufficiently high to damage sensitive plants and could contribute to fluorosis.
Source: 2

#180
Dawson, Alden B. "The hemopoietic response in the catfish, Ameiurus nebulosis, to chronic lead poisoning." Biol. Bull., 68(3):335-346 (1935).

With prolonged exposure to a solution of lead acetate, definite evidence of absorption of lead was obtained in the catfish. The surface mucus did not constitute an efficient barrier to the entrance of the metal. The degree of destruction of the erythrocytes was used as a measure of the rate of the absorption of lead. Following the early evidences of injury to blood cells, a mild regenerative response occurred, but eventually a pronounced secondary anemia was produced. Little phagocytosis of dead cells occurred in the peripheral circulation, but a progressive storage of the pigment derived from dead red blood cells was found in the interstitial tissues of the liver, spleen, and mesonephros. The hepatic cells also became crowded with pigment granules. No storage was observed in the heart. The pigment was accumulated chiefly in macrophages of local origin, which, after ingesting erythrocytes, desquamated and migrated into the connective tissue. Monocytes and cosinophiles increased slightly in number in the blood stream, but the most striking change occurred in the number of atypical thrombocytes, and spindle cells which may belong to the thrombocytic series. The endothelium of the heart showed marked proliferative activity. In some regions there was localized differentiation of erythrocytes. In other regions the atypical elongated cells were formed in large radiating clusters on the surface of the ventricular trabeculae. No explanation of the latter response to lead poisoning can be given.
Source: 1

#439
Dean, C.E., and D.R. Davis. "Ozone air pollution and weather fleck of tobacco." Florida Univ., Gainesville, Agricultural Experiment Station and Florida Univ., Gainesville, Dept. of Agronomy, Circ. S-218, 10 p. (May 1972).

Air pollution in the form of ozone can cause serious economic loss to tobacco in Florida. Ozone-induced weather fleck is characterized by small grayish-brown spots on the leaves, most prominent on the upper surface. Only mature leaves are usually affected. The normal ozone concentration in the lower levels of the atmosphere is 3 pphm or less, far less than the maximum allowable concentration of 10 pphm for 8 hr or longer. Ozone concentrations generally drop during the night, reaching their lowest levels just before sunrise. After sunrise, concentrations rise sharply, reaching a maximum near or shortly after mid-day. Daily concentrations generally reach highest levels in the late winter, spring, and early summer, which spans the tobacco production season in Florida and neighboring states. Usual concentrations of 1-3 pphm do not affect tobacco. Concentrations of 4 pphm or more may be associated with various weather systems which may adversely affect tobacco. High ozone concentrations in association with ozone-rich air masses and with air pollution are the ones that pose the greatest threats to tobacco. Tolerance or resistence in tobacco varieties can reduce the risk of weather fleck injury; however, when ozone concentrations become high enough, almost any variety can be damaged if soil moisture is excessively high. Advisories on future ozone levels are released daily by the National Weather Service during the tobacco production season, so that growers can take steps to minimize losses from weather fleck. Courses of action are rapid removal of all marketable leaves at a susceptible maturity level and/or withholding irrigation so that the plants will not be predisposed to fleck injury.
Source: 1

#317
deCormis, L. "Action compare de l'anhydride sulfureux et des derives fluores sur quelques vegetaux." [Comparison of the effects of sulphur dioxide and of the derivatives of fluorine on a few plants]. Proc. Intern. Clean Air Cong., (London), 6(5):171-173 (1966).

The frequent absence of a correlation between plant damage and air pollution in the vicinity of a plant emitting 400 tons per day sulfur dioxide and 150 kg per day fluorine led to studies of the nature of the absorption of both pollutants in plants. Both fluorine and sulfur dioxide are absorbed by leaves of tomato plants in proportion to the amount applied. However, absorbed sulfur migrates within the plants and is distributed as the sulfur normally found in plants. Fluorine is accumulated by the leaves, resulting in eventual necrosis beyond a certain limit; these limits have to be separately defined for each species of vegetation. Because sulfur is metabolized in part by the plant, it cannot have a cumulative toxic effect when applied in subtoxic quantities.
Source: 1

#319
deCormis, L. "Absorption et accumulation du fluor atmospherique par les feuilles de certains vegetaux herbaces." [Absorption and accumulation of atmospheric fluorine by the leaves of certain herbaceous plants]. Ann. Physiol. Veg., 10(4):251-262 (1963).

The effects of atmospheric fluorine compounds, such as are emitted from aluminum industries, on various leafy plants are investigated. Tomato, bean, and tobacco plants were grown under controlled conditions and subjected to varying hydrogen fluoride concentrations and different atmospheric conditions. The rate of absorption of atmospheric fluorine is clearly proportional to the concentration, time of exposure, and relative humidity. The fluorine is accumulated near the edges of the leaves and results in necrosis in that area. The level of toxicity varies from plant to plant. It can be attained from a heavy concentration of short duration, or more probably from a semi-permanent pollution of low concentration. The difference between fluorine and sulfur dioxide absorption is explained.
Source: 1

#318
deCormis, L. "Absorption of fluorine solutions and migration of fluorine in the tomato." Ann. Physiol. Veg., 10(3):155-169 (1968).

Studies were made to determine whether fluorine absorbed by the leaves of tomato plants can be displaced toward the roots and whether the fluorine contained in the soil can be absorbed by the roots and then displaced toward the leaves. In the first part of the study, fluorine was introduced to the aerial parts of tomato plants, either by soaking the leaves or the leaf stalks with a hydrofluoric acid solution of 4 g/l of fluorine in two tests, the first lasting 2 minutes, the second, 4 minutes. The soaked leaves were rinsed twice in distilled water and their fluorine contents

were measured and proved to be, respectively, 319 and 409 ppm, indicating that absorption of the fluorine ion is rapid. In the second part of the experiment, tomato plants were grown in various cultivation environments to which fluorine solutions were added. Tabulated data for both parts of the experiment revealed that fluorine moves normally from the leaf stalk of absorption to the leaflets, the stems serve essentially as a passage area, an appreciable quantity of fluorine is still found in the stem at the time of collection, there is practically no passage of fluorine to the roots, and that if the cultivation environment contains a large quantity of fluorine, the latter is not noticeably displaced toward the leaves even if it is absorbed in small parts of the roots.
Source: 1

#321
deCormis, Louis. "Degagement d'hydrogene sulfure par des plantes soumises a une atmosphere contenant de l'anhydride sulfureux." (Liberation of hydrogen sulfide by plants subjected to an atmosphere containing sulfur dioxide). Compt. Rend. (Paris), 266(7):683-685 (Feb 12, 1968).

Tomato plantings exposed to 5-10 times 10 to the minus 6th power ml SO_2 per cu m air release H_2S. In a series of consecutive air samples of the enclosed cage with the plantings, the amount of H_2S expired by the plants is shown to decrease from 145 microgram/cu min the first half-hour after exposure, to traces about two hours later. If the same plants are re-exposed to SO_2, H_2S is again expired, but in lower quantities than before. That the SO_2 is the direct cause of the H_2S is shown by the fact that plants not exposed to SO_2 do not emit H_2S, and by the fact that using marked SO_2 leads to the formation of radioactively marked H_2S. In another experiment with marked plant sulfates and unmarked SO_2, it is shown that the H_2S emitted is radioactively marked. Similar work on broad beans, beans, corn, and grape plants indicates that different plants emit different levels of H_2S when exposed to SO_2. This plant action on atmospheric SO_2 is believed to be a major means for the natural reduction of SO_2. Plant metabolism of SO_2 only occurs in the presence of light.
Source: 1

#59
de Cormis, L. "Quelques aspects de l'absorption du soufre par les plantes soumises a une atmosphere contenant du SO2." (Some aspects of sulphur absorption by plants subjected to an atmosphere containing SO2). Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 75-78 (1968).

Tomato plants the roots of which were treated with radioactive sulfur dioxide absorbed sulfur in quantities that decreased rapidly to stabilize around the fourth day following fumigation. When the same plants were cultivated on liquid matter, radioactive sulfur was found in the roots and in the liquid matter of the culture. This is indicative of elimination by the roots. Immediately after treatment, 98% of the absorbed sulfur was in the form of sulfates. At the end of 15 days, 92.5% was in the form of sulfates, 2.5% in

the form of sulfurated amino acids, and 5% in the form of sulfurated proteins. These results show that SO_2 is metabolized by plants and excludes the hypothesis of plant poisoning by cumulative SO_2 action. Tomatoes and other plant growing in SO_2 atmosphere also gave off hydrogen sulfide. The discharge came mainly from atmospheric SO_2 but partly from sulfur in the plant. Unlike the absorption of SO_2, the release of H_2S depended on light. The absence of damages when pollution by SO_2 occurs in the dark and the discharge of H_2S only when plants are illuminated open new possibilities for studying the metabolism of sulfur in relation to atmospheric pollution by SO_2.
Source: 1

#429
deCormis, L. "Dix annees d etude des repercusseions de la pollution de l air sur les vegetaux." (Ten years of a study on the effect of air pollution on plants). Text in French. Inst. National de la Recherche Agronomiques, Paris (France), Lab d etude de la Pollution Atmospherique, 62 p. (1970).

This report deals with the effect of sulfur dioxide and hydrofluoric acid on plants. The SO_2 essentially causes necrosis in areas between the leaf veins, turning the green color into ivory or reddish brown, depending on the species. Necrosis appears generally on older leaves, and does not subsequently spread beyond the originally afflicted area. The death of a whole tree or shrub due to the presence of SO_2 in the air is not known to have ever occurred. The phytotoxidity of SO_2 is at its maximum in weather conditions with close to 100% humidity. In darkness, the pollutant has generally no effect on plants. Necrosis caused by HF appears initially at the leaf edges, but then often progresses to the inner leaf area. Trees bearing stone fruit can sometimes show leaves with little apparent necrosis caused by HF, but the leaves fall prematurely. Cherry, pear and apple trees afflicted by the effect of HF may show a very small amount of necrosis on their leaves, but the fruit can be marked and thereby become unsaleable. By induced artificial air pollution and other means of comparative cberservation, agricultural researchers in France are working on the problem of which varieties of trees, potatoes, clover, and grasses show a greater resistance to SO_2 and HF pollution.
Source: 1

#1927
deCormis, L. "Effet sur les vegetaux de la pollution de l'air d'origine industrielle." (Effect of industrial air pollution on vegetation). Text in French. Ann. Mines (Paris), 11:15-20 (November 1970).

The two major pollutants of plants are sulfur dioxide and fluorine compounds. SO_2 causes necrosis of leaves but the vegetation resumes after the pollution wave has subsided. The killing of tree or of shrubs has never been observed. Under conditions of maximal photosynthesis and of high relative humidity, the noxious effect of SO_2 is at its peak. At a subnecrotic level of SO_2, plants absorb SO_2, then re-emit part of it as SO_2, another part as hydroge sulfide, and adsorb a third part which appears in sulfates, proteins, and in sulfonated aminoacids. The absorption of SO_2 and its reduction by the plant. Fluorine compounds in the atmosphere cause leaf necrosis at 10 to 100 times

lower levels than SO_2. In contrast to SO_2, necrosis develops slowly from the periphery to the center of the leaves. Fluorine ions do not participate in plant metabolism at any level. Since some highly necrotic leaves exposed to fluorine contain only traces of F (20 to 40 ppm) while leaves of other plants contain up to 1000 ppm F without signs of necrosis, analytical findings are of no use in the determination of the effect of fluorine on vegetation. A high level of fluorine in the atmosphere will kill plants. Effects of pollutants on vegetation cannot be predicted because they depend, in each case, on crop, locality and growth season.
Source: 1

#1030
deCormis, L. "Zanieczyszczenie atmosfery a roslinnosc." (Atmospheric pollution and vegetation). (Presented at the French-Polish Symposium on Air Pollution Control, Paris, France, Nov. 17-21, 1969.) Air Conserv., (English translation from Polish of: Ochrona Powietrza), 4(5):22-31 (1970).

The effects of sulfur dioxide and fluorine compounds on vegetation were studied in two regions characterized by different topographies and climatic conditions. The relative susceptibilities of various plant species to SO_2 were investigated in a spacious valley, with little or no wind and a high frequency of fog, where the major emission source was coal and heavy oil combustion and natural gas refining. The effects of SO_2 were characterized by interveinal necrosis, blotches, and defoliation. The effects of fluorine compounds, particularly hydrogen fluoride, were observed in narrow valleys with shifting wind patterns where aluminum smelters were the major source of pollution. The essential feature of fluorine action was the progressive development of the necrotic zone. Plant indicators were discussed.
Source: 1

#1031
deCormis, L. & J. Bonte. "Etude due degagement d'hydrogene sulfure par des feuilles ayant recu du dioxyde de soufre." (Study of the release of hydrogen sulfide by leaves of plants which were exposed to sulfur dioxide). C.R. Acad. Sci. Paris, Ser. D, 270:2078-2080 (April 27, 1970).

Leaves from the same level of a grapevine plant which was exposed for 15 minutes to an atmosphere containing 20 ppm SO2 were observed to release SO2 and H2S when brought into contact with paper impregnated with zinc acetate. Placed into darkness following fumigation, no H2S was released but SO2 was, irrespective of illumination. The same phenomenon can be achieved if stems of isolated plant leaves are dipped in a sodium sulfite solution. Absorption of sodium sulfide does not lead to a release of SO2. When exposed to light, part of the absorbed exogenic SO2 is reduced by the plant to H2S and released as such. The absorption of gaseous or liquid sulfide (H2S, Na2S) resulted in the release of H2S only, but did not cause leaf necrosis.
Source: 1

#320

deCormis, L., J. Cantuel, and J. Bonte. "Contribution a l'etude de l'absorption du soufre par les plantes soumises a une atmosphere contenant du dioxyde de soufre." (Contribution to the study of the absorption of sulphur by plants exposed to an atmosphere containing sulphur dioxide). Pollut. Atmos. (Paris), 44:195-202 (Oct-Dec 1969).

Tomato plants growing out of a plastic sheet-enclosed earth-compost mixture or sand with a nutrient solution, were exposed to atmospheres with different constant contents of specially prepared sulfur dioxide, some of which was taggered with the radioactive (35)S isotope. The methods of preparation of the atmosphere, of extraction and determination of 'mineral' and 'organic' S absorbed by different parts of the plant, and a measurement of radioactive emissions are described in detail. The tomato plant absorbs SO_2 from SO_2 -bearing air in proportion to the latter's concentration in air. This absorption process is fast and is accompanied by a release of hydrogen sulfide and a migration of the absorbed S to the various parts of the plant. This migration may ultimately result in an elimination of S by the roots. Whenever the S concentration in the plant had appreciably increased during fumigation, it decreased slowly as soon as fumigation was discontinued. S absorbed in this manner participated normally in the metabolism of the plant, since a large share of S was found in the form of a sulfate as well as of amino acids and S -bearing proteins. Absorption of atmospheric SO_2 and the associated H_2S emission require the presence of light and, thus are tied to the photosynthetic activity of the plant. Studies of factors contribution to the opening and closing of the stomata, of the role played by the photoreductor elements, and of the activity of the root system as a means of controlling the S concentration in the plant are being planned.
Souce: 1

#57

Dedolph, R., G. TerHaar, R. Holtzman, and H. Lucas, Jr. "Sources of lead in perennial ryegrass and radishes." (Presented at the American Chemical Society of National Meeting,157th, Division of Water, Air and Waste Chemistry, Symposium on Air Conservation and Lead, Minneapolis, April 1969). Environ. Sci. Technol., 4(3):217-223 (March 1970).

Experiments were designed to study the role of air, water, and soil lead content as sources of lead in plants. Plants were grown in chambers, with half the samples receiving unfiltered air. The water applied was either lead free or contained 40 micrograms of Pb/liter as $PbCl_2$. Six successive harvests of ryegrass were made, followed by 3 harvests of radishes. Plants were also grown in a greenhouse. Plants were uniformly watered; half received unfiltered air. Radishes and ryegrass were also grown in a field adjacent to a highway in Detroit. Rows planted at right angles started at 20 feet east of the roadway and extended for 500 feet. Soil-lead contents were determined in samples at 20, 40, 70, 120 and 510 feet from the roadway along transects normal to the roadway. Results showed that only air and soil were significant sources of lead. Experiments affirmed that both grass and radish leaves derived 2-3 micrograms of lead/gram dry weight from soil sources. Leaf-lead levels in excess of this were derived from, and quantitatively related to, atmospheric lead concentrations. Lead levels in radish roots were less than or equal to soil-derived-leaf-lead levels. The lead concentration in the edible portion of the radish plant was apparently unaffected by variations in lead concentrations in either soil or air. Collectively, data would not support a contention that the food of prehistoric man contained only a small fraction of the lead in the food of contemporary man, unless it is assumed that prehistoric man assiduously eschewed plants as a food source.
Source: 1

#1051
DeKoning, W.H., and Z. Jegier. "Effects of sulfur dioxide and ozone on Euglena gracilis." Atmos. Environ. (London), 4(4):357-361 (1970).

Euglena gracilis, a unicellular algae, is shown to be a sensitive indicator of sulfur dioxide since its rate of photosynthesis is quantitatively related to the presence of SO_2. Fumigation of Euglena cells with 2.2 ppm SO_2 increased the rate of photosynthesis by 4.9%, while fumigation with 5.0 ppm decraased the rate by 6.2%. The decrease was followed by an increase of chlorophyll a content. Fumigation with 0.5 ppm ozone decreased the rate of photosynthesis by 5.0%, and the effects of mixtures of SO_2 and ozone on photosynthesis of Euglena cells appeared to equal to the sum of the individual effects of each pollutants.
Source: 1

#1847
Delzenne and van Haluwyn. "Contribution a l'étude de la distribution des lichens epiphytes dans le nord de la France. Application au probleme de la pollution atmospherique." [Contribution to the study of the distribution of epiphytic lichens in northern France. Application to the problem of air pollution]. Pollut. Atmos. (Paris), 15(60):415-420 (Oct.-Dec. 1973).

The distribution of such epiphytic lichen species as Lecanora, Parmelia acetabulum, and Lobaria pulmonaria, as well as sulfur dioxide and soot concentration measurements performed during January, February, and March, 1973, and the North Department and in the Lille industrial agglomerations are described. While L. conizaeoides and P. acetabulum, species resistant to air pollution, were widely spread in most of the area studied, L. pulmonaria, being highly susceptible to air pollution, was found only in three sites in the area where air pollution was lowest. Lichenological studies and actual SO2 and soot concentration measurements permitted distinction between nine different zones of air pollution. The SO2 concentrations measured in the Lille industrial agglomeration ranged from 96 to 206 micrograms/cu m in January, from 116 to 207 micrograms/cu m in February, and from 70-110 micrograms/cu m in March, while the soot concentrations were in the respective ranges of 71-124 micrograms/cu m, 71-103 micrograms/cu m and 62-97 micrograms/cu m.
Source: 1

#776
DeMerre, Leon, J. "A study of reactions in Los Angeles smog (final report)." Stanford Research Inst. Calif., SRI Proj. C-1120,Rept. 3, 123 p., (August 1, 1955).

Generated smogs were studied and their properties determined by the following criteria: plant damage, eye irritation, reduction in visibility, and oxidant concentration. A chamber was constructed in which the average light intensity was made to approximate midday sun. The chamber was about 500 cu ft in volume and was so constructed that the residence time for a parcel of air passing through it could be varied from a few minutes to two hours. Night air was irradiated in the

chamber and passed into a smaller fumigation chamber in which the number of plants and their positions were dictated by statistical considerations. Phytotoxic substances were produced in the night air by irradiation, as proved by the subsequent markings obtained on the plants. In addition, these markings were identical to those observed in the field after a natural smog attack. Among the species used, Romaine lettuce gave very reliable markings and Poa annua and Pinto beans typical smog damage, whereas spinach exhibited no characteristic damage. On adding 5 ppm gasoline to night air and irradating the mixture, heavy plant damage was obtained. No damage was detected using 1-hexene. Plants grown in the greenhouse receiving carbon filtered air remained undamaged on smoggy days. Carbon-filtered air is not necessarily free from contamination; however, certain phytotoxic substances were reduced below the threshold of plant damage. When 20-40 ppm ozone was added to carbon-filtered air, the resultant marking was not very different from smog damage. Sixty pphm ozone resulted in death of the leaves in less than two hours. The results of eye irritation tests showed a trend toward an imcreasing irritation from mixtures going from carbon filtered air to night air to irradiated night air. There was a higher level of oxidizing compounds at the outlet of the irradiation chamber than at the inlet. Increases in nitrogen oxides levels were observed when the ozone stream was a flowing. The level of nitrogen dioxide without ozone varied between 1 and 5 pphm. During ozonization of the air stream, the levels of combined oxides went as high as 20 pphm. The hazemeter selected to investigate any decrease in visibility was too insensitive for the particular situation; otherwise, all tests performed supported the premise that smog is formed by the irradiation of night air and as the result of a photochemical reaction.
Source: 1

#1052
Dept. of Agriculture, Forest Service. "Our Air: Unfit for trees." NE-INF-14-72. 23 p. (1972).

Major sources of air pollution, pollutants, and their effects on trees are reviewed. Effects depend on type of tree, genetic make up, stage of growth, nearness to pollutant source, pollutant concentration, and the pollutant duration. A list is presented which includes the known responses of both hardwood and softwood trees to sulfur dioxide, hydrogen fluoride, ozone, nitrogen oxides, peroxyacetyl nitrate (PAN), ethylene, chlorine, hydrogen chloride, and mercury vapor.
Source: 1

#1053

Dept. of Trade and Industry, Great Britain, Programmes Analysis Unit. "Section IV(F): The damage to agriculture." In: An economic and technical appraisal of air pollution in the United Kingdom, London, H. M. Stationery Office, p. 140-149, 1972.

The effect of air pollution on agricultural plants and animals in Great Britain is described. Sulfur dioxide can affect life in three ways: as a constituent of the air, as rain, or as acidic mist. Depending on its form, SO_2 can affect the soil and the health of the plants, cause delayed blooming, premature senescence, and leaf damage. Smoke reduces the supply of light radiation for photosynthesis and may block the stomatal pores. Fluorine, besides retarding growth in plants as a result of destruction of tissue, can damage animal bone and teeth. Oxides of nitrogen are emitted in relatively small quantities compared to SO_2. The oxidizing action of nitrogen dioxide or nitric acid washed out by rain could produce direct damage to foliage. Other pollutants which adversely affect vegetation include lead, ethylene, ozone, and organic sulfur compounds. A discussion on the cost of damage by air pollution to agriculture in Great Britain is included.
Source: 1

#323

Desbaumes, P., and E. Bovay. "Determination des immissions fluorees au moyen d appareils d absorption statique, type Harding modifie." (Determination of fluorine-immissions by means of static absorption apparatus (modified Harding method). Text in French. Revue Suisse de Viticulture et Arboriculture (Lausanne), 3(3):75-77 (May-June 1971).

A modified Harding apparatus was used to determine the correlation between fluorine in the air and in plant leaves. The device consists of a galvanized armature attached to a pole, a group of superimposed discs holding filter paper, and a conical roof protecting the device from rain and bird droppings. The fluorine content was determined by the Belcher and West method modified by Sulzberger afater the calcination of a one gram filter paper sample with calcium hydroxide. Measurements were taken near an aluminum factory and near a fertilizer plant. The fluorine content in the filters was directly proportional to the duration of exposure and inversely proportional to the distance from the source of the fluorine. The absorp- of fluorine by filter paper is much less than by plant tissues because of respiration and evapotranspiration.
Source: 1

#440

DeSloover, J. "Groupes ecologiques, combinaison d especes indicatrices et tolerance a l egard des pollutions chez les lichens piphytiques." (Ecologic groups, combinations of indicator species and tolerance for pollutants in epiphytic lichens). Text in French. TERPLAN-Statni ustav pro uzemni planovani, Ustav krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiiny, Sbornik Z. Mezinarodni Konference, Prague, Czechoslovakia, p. 18-24 (September 1971).

The method of the average specific concomitants, and the method of the relative cumulative frequencies, both applied to the study of the air quality by determining changes in the composition of associations of epiphytic lichens due to air pollution, are compared. The method of the average specific concomitants derives air quality indices from the average number of epiphytes surrounding a given species in a given site. Compared to the former, the method of the relative cumulatives frequencies delivers more precise data on the air pollution-generated changes in the compositon of epiphytic associations. Twenty-eight out of a total of 65 epiphytic species found in the Dendre valley (Belgium) have been retained on the basis of their absolute frequencies for the determination of the reltive cumulative frequencies to obtain groups by variance analysis, adopting two-by-two comparisons.
Source: 1

#1054
Didier, B. "Le fluor, oligo element dynamique pour le mais." (Fluorine, a dynamic trace element for corn). Text in French. C. R. Acad. Sci. Paris, Ser D., 269:1767-1769 (November 3, 1969).

Corn plants grown in an artificial medium containing 0, 0.5, 1, 2, and 4 mg sodium fluoride yielded after 64 days 19, 30.8, 31.4, 39.6 and 27.3 g dry weight of vegetable matter respectively. A graphic analysis of the growth curve of corn under given experimental conditons yielded 1.8 mg NaF/1 as the optional growth-promoting quantity of NaF for corn. In the presence of aluminum salts and of 0, 0.5, 1 and 4 mg sodium fluoride, after 65 days corn plants yielded 18.6, 43.26, 11.4 and 10.54 g dry weight of vegetable matter. Fluorine in trace quantities is necessary for the optimal growth of corn in an artificial medium; at higher levels, However, fluorine is toxic and inhibits growth. The toxicity of fluorine can be attenuated by an excess of aluminum in the solution as a result of the probable formation of aluminum fluoride. The optimal concentration of fluorine varies from 250 to 800 microgram/1 g depending on the concentration of aluminum in the medium.
Source: 1

#979
Dimitriades, B., and M. Whisman. "Carbon monoxide in lower atmosphere reactions." Environ. Sci. Technology, 5:219-222 (1971).

To understand more fully pollution problems posed by carbon monoxide, an experimental study of CO reactions in the lower atmosphere was conducted. The study involved exposure of CO to lower atmospheric conditions simulated in the laboratory and measurement of the rate of CO oxidation to CO_2. To simplify analytical measurements, the CO reactant was mixed with C^{14} labeled CO. Results suggested that the CO oxidation rate in the lower atmosphere is approximately 0.05% per hour of day or night-time, resulting in a lifetime of 0.3 year; observed rates cannot be examined only by CO reactions with oxygen atoms and ozone; but the presence of CO at typical levels does not necessarily effect the process of photochemical smog formation.
Source: 5

#1055
Dinh, D.L., and G. Buchloh. "Wirkung von Fluor-Emissionen auf Pollenkeimung und Fruchtwachstum." (The effect of fluorine emissions of pollen germination and fruit growth). Text in German. (Presented at the Hohenheim University Umweltforschung Seminar, 1971.) Umweltforschung, 58:24-25 (1971).

The effects of the fluorides of sodium, hydrogen, potassium, magnesium, calcium, and strontium on pollen, helium, and fruit growth were studied. Univalent fluorides except for HF in concentrations of up to 10 ppm had no effect on the pollen germination and on the helium, and even seemed to beneficial for germination. Shrinkage in the apical region and skinny degeneration of the epidermis during fruit growth were observed. Such fruits were of reduced size and of unacceptable quality. These and other findings suggest the pollen growth and germination-inhibiting effect of calcium fluoride.
Source: 1

#324
Djuric, D. and Z. Kerin. "Lead contamination of environment in Meza Valley, Yugoslavia: Some considerations on lead content in soil and plants." (Presented at the International Conf. on Chemical Pollution and Human Ecology, Prague. 10 p.) (Oct. 1970).

As part of a broad ecological study of lead contamination, soil samples and underground parts of some vegetables were analyzed for lead by the dithizone method. Vegetables fell into three groups: those with a relatively high Pb content (over 30 mg/kg); those with a medium Pb content (over 10 mg/kg); and those with a low Pb content (under 5 mg/kg). Variations in Pb content in the same kind of vegetables represented variations in soil Pb content and absorption. Variations between different kinds of vegetables were due to differences in plant physiology and capacity of absorption, shape and size of root, and depth of root in soil. Lead content was higher in vegetables grown in summer and fall than for the same vegetables grown in spring. Lead absorption coefficients were calculated for underground parts of vegetables according to the relation between the Pb content of the plant and total Pb content of soil and according to the relation between the Pb content of the plant and the AL-soluble Pb in soil (AL is the ammonium lactate acetic acid mixture). The latter method gave much less dispersed coefficients, indicating that AL-soluble Pb represents much more authoritative data for determining absorption coefficients than total soil Pb.
Source: 1

#441
Dobrovolskiy, I.A. "Vliyaniye dymo-gazovykh vydelniy promyshlennykh predpriyatiy krivorozhskogo zhelezorudnogo basseyna na rasteniya." (The effect of industrial smoke and gas exmanations from the Krivoy Rog iron ore exploitation area on plant growth). Text in Russian. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw zanieczyszczen Powietrza na lasy, 6th, Katowice, Poland, p. 257-260, Sept. 9-14 (1968).

The Krivoy Rog iron ore field is located within the Steppe region of the Ukraine, characterized by 408 mm of precipitation per year, by an average deficit of humidity of 3.5 3.8 mm, a minumum temperature of -32 C, occuring in January, and a maximum temperature of 39 C occurring in July. Sulfur dioxide, hydrogen sulfide, nitrogen oxides, carbon monoxide, ammonia, soot, and dust constitute the main air pollutants of this region. Their presence may be perceived at more than 50 km distance from their emission source. Leaf burn and decrease in leaf size, as well as 40-85% decrease in sprout and an inhibition of flowering and fruit bearing are among the main damaging effects produced on plants. No plants seem to resist the damaging effects nearby the chemical coke industries. A considerable decrease in photosynthesis and catalase activities as well as an inhibition in the excretory function of the flowers is observed in all plant species grown within the polluted regions. The coniferous species as well as the lime and plum tree appear to be the most susceptible species to sulfur or nitrogen oxide containing gases. The apricot and the white acacia trees appear to be the most resistant species to these pollutants.
Source: 1

#442
Dobrzanski, B., J. Glinski, and M. Misztal. "Wplyw pylow z cementowni ni niektore wlasciwosci gleb." [Effect of cement plant dusts on some properties of soil]. Rocz. Glebozn.,21(2):409-420 (1970).

Humus content, pH, calcium carbonate, total vanadium, copper, manganese, strontium, chromium, and nickel were determined from soil horizons 0-10 cm and 10 - 20 cm deep. The highest CaCO3 content (over 4%) was found within 200 m of the plant. The presence of cement dust resulted in an increase in soil particle aggregation. No distinct correlation was observed between soil pH and CaCO3 content. The microconcentration of elements was a function of both the concentration of cememt dust and soil properties. Strontium and Mn were particularly sensitive indices of dust content.
Source: 1

#325
Dochinger, L.S. "The impact of air pollution in eastern white pine: The chlorotic dwarf disease." J. Air Pollution Control Assoc., 18(12):814-816 (December 1968).

Chlorotic dwarf is a serious disorder of eastern white pine in young plantations. Diseased trees are stunted and possess only current mottled foliage. Investigations into this problem were to define its symptomatology and etiology and to develop measures for control. Previous work had shown that susceptibility to chlorotic dwarf is genetically controlled and that the disease results from an aerological agent acting directly upon the foliage. By controlling the atmospheres around chlorotic dwarf field trees to exclude gaseous dispersoids 0.3 micron or smaller, evidence was obtained to prove that chlorotic dwarf is effected by the injury of gaseous dispersoids on the foliage of susceptible individuals.
Source: 1

#147
Dochinger, L. S. "Can trees cleanse the air of particulate pollutants?" Int. Shade Tree Conf. Proc., 48:45-48 (1972).

At two sampling sites in Ohio, particulate pollutants were assayed in (1) a treeless area, (2) under a canopy of hardwood trees, and (3) under a canopy of conifer trees. Studies of dustfall and suspended particulate matter indicated that trees have the capacity to reduce particulate pollutants in the atmosphere.
Source: 2, 6, 7

#525
Dochinger, L. S. "Christmas trees and air pollution." Horticulture, 51(12): 40-42 (December 1973).

Christmas tree growers in certain regions of mountainous Appalachia are experiencing air pollution injury in their plantations. Damages to the trees include discoloration, foliage falling off, death of buds and abnormal growth. The most important tree pollutants are oxidants, fluorides, and sulfur dioxide. Also, there is a diagram displaying the relative tolerance of certain conifer species to sulfur dioxide, hydrogen fluoride, and ozone.
Source: 2

#1164
Dochinger, L. S. "Air pollution problems in nurseries." Reprinted from New Horizon's Day. p. 1-5 (1974).

As urbanization and industrialization intensify, harmful gaseous and particulate emissions will continue to affect nursery and ornamental plantings. Although efforts are being made to control emissions at their sources, plant damage will increase because of our inability to curb chronic air pollution. Nursery crops are injured primarily by ozone, fluorides, and sulfur dioxide, but other phytotoxicants, such as hydrogen chloride, ethylene, oxides of nitrogen, and acidified particles, may be injurious too. Investigations should be accelerated to provide information on (1) the production of genetically superior varieties of ornamentals for community plantings, (2) chemical protection for alleviating injury to shade trees by air pollutants, (3) a more comprehensive understanding of multiple stresses on the whole plant from germination until the completion of its reproductive cycle, and (4) dose-response data on the effects of acute and chronic fumigation on plant growth and yield.
Source: 6

#120
Dochinger, L. S. "Atmospheric cleansing of gaseous and particulate pollutants by forest trees." 30 pp. (1974).

Experimental data citing the uptake of ambient SO_2 and NO_2 is mentioned. Several authors suggest that planting of trees in strategic locations can reduce pollution. Factors affecting leaf sorption are discussed as well as translocation, utilization and soil deposition of the pollutants.

Facts: Distance of the forest belt from the pollution source shouldn't be too far.

To stop gases, dense stands are needed whose areas are 5 x the height of the stand at the windward side and 25 x at the leeward side.
Source: 7

#121
Dochinger, L. S. "Improving city air quality with trees." U. S. D. A. Forest Service, N. E. Forest Expt. Station, Forest Insect & Disease Lab, Delaware, Ohio, 17 pp. (No date).

This review report concerns itself with the effects of air pollution on urban communities and the problems involved in improving city air quality with forest greenbelts. The sources of city air pollution are discussed. Experimental data are cited proving that alfalfa absorbs SO_2 + NO_2; oats absorb NO_2 and plants in general remove O_3. The suggestions of other authors who indicate that plants may serve as green air conditioners are discussed.
Source: 2, 7

#553
Dochinger, L.S., and K.F. Jensen. "Air pollution." U.S. Dept. of Agriculture. Agric. Handb. U.S. Dept. Agric., 470:107-113 (March 1975).

The author briefly reviews the primary offenders of plant damage: O3, SO2, and fluorides. The sources of each type of pollutant is noted, and symtoms of each type of pollution for both conifers and hardwoods are discussed.
Source: 2

#1166
Dochinger, L.S. and K.F. Jensen. "Effects of chronic and acute exposure to sulfur dioxide on the growth of hybrid poplar cuttings." Environmental Pollution, 9:219-229 (1975).

Hybrid poplar clones were fumigated in controlled-environment chambers with either 5 ppm sulphur dioxide for 1 1/2, 3 and 6 h or with 0.25 ppm sulphur dioxide for six weeks. Multivariate analyses were made from shoot-growth data before and after treatment and on the foliar injury induced by SO_2. Both short- and long-term fumigation produced similar plant-behavior responses to the two SO_2 concentrations.
Source: 6

#1165
Dochinger, L. S., and T. A. Seliga. "Acid precipitation and the forest ecosystem." APCA Journal, 25(11):1103-1105 (November 1975).

SO_2 wastes result in acidity falling to the earth in wet or dry forms, to wreak havoc with the forest ecosystem. Acidification of lakes has resulted in extinction of fishes in certain areas. The exact effect of acidity on fish isn't known, but it is suspected that it alters calcium metabolism. Adverse effects of strong acids in precipitation effect bacteria, algae, macrophytes, salamanders and invertebrates as well. Increased levels of toxic metals are due to direct input or to increased soluability due to acid conditions or both. If the ecosystem is well buffered, acidity in precipitation will have little effect but if not, it will have drastic short and long range effects. Forest canopies filter out sulfur and hydrogen ions from precipitation, and acidity of bark and development of cuticular features such as frequency and size of stomates can be used as biological indicators of sulfur pollution and acidification. Vegetation developing in sandy soils is more vulnerable to pollution than those plants in buffered soils of high clay content and base exchange capacity. Acidity in rain can produce changes in the phynology of foliar organs. Ammonia combines w/sulfate ions in the atmosphere and tends to neutralize atmospheric acidity.

Simulated rain (1) caused direct foliage injury, (2) induced visual symptoms, 3) induced poorer germination of spruce seeds, 4) induced leaching of nutrients from foliage of various angiosperms, 5) increased leaching from humus, 6) increased erosion of epicuticular waxes on oak and bean leaves, 7) decreased uptake of nitrogen by endomycouhizae of sweetgum seedlings, 8) inhibit reproduction of root-knot nematodes, 9) inhibit development of bean rust and production of telia by oak leaf rust fungi, 10) inhibit or stimulate development of halo blight in bean seedlings depending on the time of the disease cycle when the "rain" was applied, 11) inhibit nodulation and fixation of nitrogen by Rhizobium in bean and soybean seedlings.
Source: 1, 6

#1056
Dochinger, L.S., and C.E. Seliskar. "Air pollution and the chlorotic dwarf disease of eastern white pine." Forest Sci., 16(1):46-55 (March 1970).

Chlorotic dwarf is a serious disorder of eastern white pine (Pinus strobus L.) in young plantations. Diseased trees are characterized by stunted roots and tops, short and mottled needles, and premature shedding of foliage. In experiments begun in 1963, chlorotic dwarf pines were placed inside plastic-covered wooden frame chambers that were equipped with electric blowers and charcoal or quartz stone filters. By 1964, a striking recovery was observed on trees in the chambers with charcoal filters. Premature loss of foliage stopped, needles were unmarked and 3 in. long. Five years later, the trees receiving the charcoal-filtered air were still vigorous. Additional experiments with chambers provided with 7 in. absolute filters for particulate removal and 3 in. charcoal filters for removal of gaseous dispersoids provided evidence that the chlorotic disorder is the result of injury from gaseous pollutants. In contrast to the complete recovery exhibited by trees in the charcoal-filtered chamber, the symptoms continued in trees protected only by absolute filters. In later fumigation chamber experiments, early symptoms of needle mottling and premature defoliation were observed on pine ramets, exposed to ambient (0.1) levels of ozone and sulfur dioxide, singly or in combination.
Source: 1

#443

Dochinger, L. S., A. M. Townsend, D. W. Seegrist, and F. W. Bender. "Responses of hybrid poplar trees to sulfur dioxide fumigation." Preprint, Air Pollution Control Assoc., Pittsburgh, 29 p. (1971). (Presented at the Air Pollution Control Association Annual Meeting, 64th, Atlantic City, June 27-July 2, 1971, Paper 71-101).

A study was conducted to determine the effects of a uniform level of sulfur dioxide on the growth rates and relative foliar injury among ramets of four hybrid poplar clones subjected to varying periods of fumigation. Rooted stem cuttings were exposed to five ppm SO_2 for zero, three, six, nine, or twelve hours in controlled environmental chambers. Multivariate analyses were made from the shoot growth measurements recorded for four weeks before and after fumigation and on the data of foliar injury induced by SO_2. Genotype, duration of treatment, and interaction between genotype and hours of fumigation were statistically significant in determining growth response and foliar injury. All partial correlations between foliar injury and subsequent shoot growth were positive and significant. Sufficient genetic variation appears to exist in this Populus hybrid to encourage selection of clones tolerant to short-term exposures to high levels of SO_2. Further studies should clarify the relationship between genetic and morphological effects upon plant responses to SO_2 fumigation and between laboratory tests of small clonal ramets and field plantings of mature trees.
Source: 1, 6

#1057

Domroes, M. "Luftverunreinigung und Stadtklima im Rheinisch-Westfaelischen Industriegebiet und inhre Auswirkung auf den Flechtenbewuchs der Baeume." (Air pollution and urban climate in the Rhine-Westphalian industrial area and their influence on lichen growth on trees). Text in German. Arb. Rheinischen Landeskunde, 23:1-133 (1966).

Lichens on tree boles were examined on 25,114 trees along streets and areas in the central part of the Ruhr District and related to air pollution concentrations. The lichens were studied with regard to physiognomy, density, and esposition, and in relation to bark characteristics of tree species. Lichens were classified into the following areas: Lichen desert, transitional zone or area of normal distribution. The lichens were sensitive to air pollution, especially sulfur dioxide emissions. The damaging influence of the town climate, especially aridity, was taken into consideration. Lichens were missing in all areas with a high degree of air pollution. These were areas of high density housing and of lower humidity than open country. Areas which had lower housing density and lower humidity also had increased lichen damage. Lichens missing in the immediate neighborhood of factories or industrial areas outside towns. Lichens growth was reduced along busy roads.
Source: 1

#777
Donaubauer, Edwin. "Sekundaerschaeden in Oesterreichischen Rauschschadensgebieten. Schwierigkeiten der Diagnose und Bewertung." (Secondary damage in regions of Austria exposed to pollution. Difficulties in diagnosis and assessment). Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza no Lasy, 6th, Katowice, Poland. 277-284 (Sept. 9-14, 1968).

Secondary damage from pollution most frequently occurs through sunburn on peripheral susceptible tree stands in clearings of wooded areas. Such trees, damaged by the sun attract pests and die. This applies especially to pine stands. In the pollution exposed areas of Aichfeld near Judenburg and Gailitz-Arnoldstein, needles of mature pine stands suddenly turned brown in 1963 following the appearance of an additional pollutant (hydrofluoric acid) into the already sulfur dioxide-polluted atmosphere (first area) and intensification of SO2 emission (second area). A contributing factor was an exceedingly cold winter with temperatures 4 to 5 C below the long-term average. Pollution-exposed stands are more susceptible to infestation with the fungus Armillaria mellen which causes great damage in Austria to pine, and deciduous tree stands. Other pests which proliferate in pollution-damaged stands are Pissodes picae, Cryphalus piceae, Ips typographus, and Pissodes harcyniae. Generally it is not easy to prove a causal relationship between emission and secondary damage; detection of damage in a pollution-exposed area is not sufficient proof. The task is easier where identical or similar stands in unpolluted areas are available for comparison.
Source: 1

#1059
Doorn, Wouter G., van. "Bioelectric response and photoresponse changes after sublethal applications of sulfur dioxide to Zinnia elegans." Iowa State Univ. of Science and Technology, Ames, Dept. of Horticulture, 54 p. (1974).

Laboratory experiments ivestigated bioelectric response potential (BEP) and photoresponse changes in Zinnia elegans var. (Canary Yellow leaf) to sudden, sublethal sulfur dioxide exposures, using the slope and amplitude of the first waveform trough as a criterion for SO2 action. Polyethylene lined test enclosures equipped with fluorescent lamps, fiberglass electrode supports, and an exterior black cloth for dark tests wer utilized as whole-plant SO2 exposure chambers to allow for the monitoring of both initial and subsequent SO2-induced plant BEP changes and photoresponses; this was in contrast to BEP experiments with Zinnia elgans by other investigators where plants were first fumigated with SO2 and then lab-tested sequentially for BEP response, resulting in uneven test-time lapses and a lack of BEP response data during actual fumigation. Low-impedance, non-polarizable, non-phytotoxic silver/silver chloride electrodes were placed in 1 cm long polyethylene plastic tubes filled with a 2% (by weight) agar plus 0.1 N potassium chloride solution in aquad and were connected to a Grass polygraph, with the strip chart speeded up to 1 cm/sec for more-detailed readout. Amplitude sensitivity settings of either 5 or 2 mV/cm were used, and the electrode placement with respect to the upper and lower leaf sides was offset by 2 cm. Sublethal SO2 injection under constant light conditions caused a BEP oscillation similar to that resulting

from a light-off response but with a definitely lowered initial stationary BEP level for SO2 concentrations of 7-100 ppm. Light-on and light-off plant photoresponses were also changed following SO2 application. Measurement of BEP was not an indication of either stomatal opening or thermocouple-detected temperature differences between upper and lower leaf sides. The method offers promise as an indicator for sublethal OS2 action on plants under field conditions since it utilizes relatively simple equipment, does not destroy the plant, and results in a reproducible and characteristic response for SO2. Source: 1

#1060

Doorn,W.G. van. "Influence of environmental factors on plant bioelectrical potential difference. Literature review." Preprint, Iowa State Univ . of Science and Technology, Ames, Dept. of Horticulture, 33 p. (1974).

A literature review on the influence of environmental factors, particularly air pollutants, on plant bioelectrical potential (BEP) is presented along with some conclusions on the physiological cause of the recorded potential differences and the possibility of using BEP measurement as an indicator for pollutant influences on plants under field conditions. Studies are cited concerning the effects of salt concentration and composition, hormone IAA, temperature, and light on BEP differences in the root environment of plants; BEP differences in the shoot environment resulting from such influences as water condition, temperature, atmospheric gas composition, presence of absence of light, light intensity and spectral composition, electrode placement, presence or absence of chlorophyll in the plant, and the presence of such air pollutants as 2, 4-dichlorophenoxy acetic acid, sulfur dioxide, chloroform, ether and ozone are also investigated. Bioelectrical potential differences are detectable between all outer parts of the intact plant and are possibly due to local differences in ion concentration of the extracellular medium and conductivity of the tissue between two electrodes. Some metabolic preocess directly linked to photosynthesis must cause the photoresponses since, among other factors, chlorophyll is needed for the formation of the BEP change. Placing two plant groups in transparent field chambers, one filtered and the other unfiltered with respect to air pollutants, is suggested as a promising method for further studying the effects of air pollutants on BEP.
Source: 1

#444

Dopp, W. "Ueber die Wirkung der schwefligen saeure auf Bluetenorgane." (The actions of sulfurous acid on flowering organs). Translated from German. Ber Deut. Botan. Ges., 49:172-221 (1931).

For determining the influence of sulfur dioxide on pollen and pollen germination, experiments were carried out either in closed containers in which a definite concentration of SO_2 had been established, or by a method in which a mixture of SO_2 and air of the desired concentration was continually passed

through a space in which the objects were located. Gasing of fresh, air-dry pollen resulted in damage illustrated by a total loss of the germinative power or a reduced percentage or retarded germination. The pollen from the gassed pollen grains frequently showed retarded growth, dependent on the atmospheric humidity content, when grown on 1.5% agar containing sucrose. Results from tests conducted on Lupinus luteus showed germination greatly reduced when the specimen was exposed to moist air, thus indicating that moist pollen was damaged much more than air-dry pollen. Tests of pollen on an artificial substrate exposed to a sufficient action of SO_2 showed either germination was destroyed or the pollen tubes remained short, split open, and emptied their content when germination did occur. The material was much more sensitive in these experiments; concentrations of 1:1000 or 1:10,000 caused a loss of germinative power after 1 minutes; harmful effects were noted in dilutions of up to 1:1,000,000; and, the harmful effect was greater with 1.5% agar than with 5% agar. Light did not influence the action of SO2 on the pollen and pollen tubes. Experiments with shoots that were flowering or about to flower showed damage to the plant manifested by having the opening of the flower, anther or stigma retarded, by a reduction of the percent germination of the pollen taken from the gassed anthers, by having the number of pollen reduced which germinated on the stigma, and by shorter lengths of the pollen tubes in the style. Specific SO_2 concentrations were not connected with visible damage to the tissues of the stigma, style, or and/or ovary.
Source: 1

#1061
Dorn, C. R., J. O. Pierce, II, G. R. Chase, and P. E. Phillips. "Study of lead, copper, zinc and cadmium contamination of food chains of man." (Final Report) Missouri Univ., Columbia, Mo. Environmental Protection Agency Contract 68-02-0092, EPA-R3-73-034, 118 p. (December 1972).

The amount of soil, vegetation, meat and milk contamination by cadmium, copper, lead, and zinc were estimated on a farm exposed to stack emissions from a lead smelter, lead ore concentrate spillage from trucks, and dust from stockpiled ore at the smelter; these values were compared with those from a farm outside the lead production area. Within 1 year, the lead concentrations in soil samples collected 60 ft., 140 ft. and 220 ft. from the highway on the test farm increased 219%, 257%, and 284%, respectively. High lead and cadmium concentrations were found in dust fall and air filter samples from the test farm, and test farm dust fall and soil samples also showed high concentrations of copper. The highest airborne, suspended Cd, Cu, Pb, and Zn concentrations were observed in winter on the test farm; this corresponded with high dust fall, soil, and vegetation levels and the time of greatest increase in lead assimilation by a test cow. There was a general dilution in the lead concentrations at each step of the food chain from soil to cattle tissue on the control farm, while biomagnification of the lead in the grass roots was observed on the test farm. On an equivalent basis, the test cow's blood Pb concentration at the end of the study period was 1/246 the test farm soil concentration and the control cow's blood Pb was 1/187 the control farm soil concentration. The liver, kidney, muscle, and milk of the test cow contained very small amounts of cadmium, and the lead levels were 2.35 micrograms/g, 3.75 micrograms/g, 0.19 micrograms/g, and 13 micrograms/g respectively. The Pb concentrations in the milk of the test cow were 1.9 times those in the milk of the control cow, and the Pb concentrations in the milk from a cow exposed only to lead ore concentrate spillage from trucks and background sources were intermediate between those of the test and control animals.
Source: 1

#326
Dost, Frank N., D.J. Reed, and C.H. Wang. "Studies on environmental pollution by missile propellants." Oregon State Univ., Corvallis Radiation Center, Air Force Systems Command/Aerospace Medical Research Lab. Contract AF33(615)-1767, Proj. 6302, Task 630204, Work Unit 630204001, AMRL-TR-68-85, 28 p. (Feb 1969).

Field evaluation of the effects of inorganic fluoride oxidizing agents accidentally released into the environment are discussed. Information is derived primarily from research previously published. The compounds reviewed are nitrogen trifluoride (NF_3), tetrafluorohydrazine (N_2F_4), oxygen difluoride (OF_2), and the interhalogens chlorine trifluoride (ClF_3), chlorine pentafluoride (ClF_5), and bromine pentafluoride (BrF_5). Nitrogen trifluoride has no effect on plants, fish or microorganisms. High concentrations cause reversible toxicity in mammals. Tetrafluorohydrazine has limited effects on plants and its reaction products are fairly harmless to fish. Mammalian toxicity is moderate but reversible. Oxygen difluoride is highly toxic to plants, but does not appreciably harm microbes or fish unless partial pressure remains high. It causes irreversible damage to mammals at very low doses, and as yet no successful decontaminant has been found. The interhalogens are highly toxic to plants. A possibly productive approach to decontamination of the highly toxic OF_2 may be through the immediate reaction of the spilled gas by reagents distributed through the cloud, at a time when concentration is high enough to permit relatively easy reaction in a limited area. The decontamination of spilled interhalogens should be easier to accomplish, since they react with almost any material they encounter. Their reactive aqueous solutions must be dealt with as well, but if the waterborne interhalogen reaction products are eluted or percolated through soil, almost all living elements in the environment will be protected. The problem of quickly and safely destroying each of the inorganic fluoride oxidizing agents in air, leaving products which may be dealt with on a non-emergency basis, is being studied.
Source: 1

#181
Draznin, Y. "The lethal equation: smog plus trees equals damage and death." Amer. Forests, 78(2):48-51, 58-60 (February 1972).

Plants are so sensitive to smog that they are proven monitoring devices for detecting pollutants in the air; except for the toxic gases carbon monoxide and hydrogen sulfide, they react to pollutants long before humans do. The villain in the matter is the automobile, a major source of the raw materials from which smog is produced. Industrial plants that burn organic fuels are also to blame. Ozone and peroxyacetyl nitrate are two very lethal products of the photochemical reaction which takes place when hydrocarbons and nitrogen oxides are acted on by bright sunshine. Smog damage is most extensive during periods of soft, luxuriant plant growth. Plants maintained with just enough water and nutrients to keep from wilting manage better than well-watered, well-fed vegetation. One way plants seem to be coping is through the development of new and more numerous smog-resistant varieties, or individuals within the varieties. DuPont and Shell Development Corporation are developing a spray or dust for external application to prevent damage to leaves at times when they are most susceptible.
Source: 1

778
Dreisinger, B.R., and P.C. McGovern. "Monitoring atmospheric sulphur dioxide and correlating its effects on crops and forests in the Sudbury area." (Presented at the Impact of Air Pollution on Vegetation Conference, Toronto, Ontario, April 7-9, 1970.) Preprint, Air Pollution Control Assoc., Toronto, Ontario Section Air Pollution Control Assoc., Pittsburgh, Pa., TR-7 Agricultural Committee, and Ontario Dept. of Energy and Resources Management, Toronto, Air Management Branch, 23 p. (1970).

Vegetation has been and continues to be injured by emissions of sulfur dioxide from mining companies in the Sudbury area. Between May and October, 1964 through 1968, approximately 200,000 hrs of air sampling were carried out at 10 Thomas autometer sites at distances of five to 40 miles from Sudbury. Sulfur dioxide was recorded for 13% of the total time the recorders were operating, and half-hr concentrations reached a maximum of 2.86 ppm 16 miles from Sudbury. During the five year period, 3365 daytime fumigations were recorded at the 10 stations, 247 of which reached or exceeded levels known to be potentially injurious to vegetation. Approximately 2100 sq miles were subjected to at least one potentially injurious fumigation and about 50 sq miles to 20 or more potentially injurious fumigations. One of the fumigations reached levels almost five times those required to cause injury. Injury was observed in vegetation near recorder stations following 62 fumigations. Buckwheat and trembling aspen were considered to be two of the most sensitive species growing in Sudbury area. To minimize SO_2 injury, ground-level concentrations and duration in the Sudbury area should never exceed 0.70 ppm for one hour; 0.40 ppm for two hrs; 0.26 ppm for four hrs; or 0.18 ppm for 8 hrs.
Source: 1

#182
Drinker, P. "Air pollution and the public health. Pollution by fluorides." (Presented at the Royal Institute of Public Health and Hygiene.) Roy. Inst. Public Health Hyg. J. (London), 20:307-316 (Sept. 1957).

The effects of sulfur dioxide, fluorides, ozone, and Los Angeles smog on plants are reviewed. The emissions of dusts, grit, and ash and their control by isolation are considered. The regulation of industrial and vehicular exhaust air pollution are presented. Fluoride contaminants mentioned are: hydrofluoric acid, silicon tetrafluoride, sodium fluoride, and calcium fluoride.
Source: 1

#896
Druilhet, A., A. Perrier, J. Fontan, and J.L. Laurent. "Analysis of turbulent transfers in vegetation: use of thoron for measuring the diffusivity profiles." Boundary-Layer Meteorol., 2(2):173-187 (Dec 1971).

The analysis of turbulent transfer is the basis for an interpretation of the growth and development rates of vegetation as a function of certain essential parameters, such as the temperature of the vegetal organs, the rate of absorption of carbon dioxide, and the water consumption. These parameters are

functions of energy and mass exchanges at different heights. Their intensities depend upon the value of the transfer coefficients in the vegetation. The aerodynamic and the thoron methods are used in this investigation. The thoron diffusivity profiles show an important distortion in the middle zone of the canopy, below the maximum of leaf density. This distortion is associated with a maximum source of sensible heat flux at these levels, which partially invalidates the aerodynamic approach.
Source: 1

#779

Dugger, W.M., and I.P. Ting. "Air pollution oxidants - their effects on metabolic processes in plants." Ann. Rev. Plant Physiol., 21:215-234 (1970).

A review of the effects of ozone and peroxyacetyl nitrate on plants is presented. The photooxidate and photolytic reactions which cause nitrogen oxide, nitrogen dioxide, and hydrocarbons to form O_3 and PAN are discussed. Light intensity during the growing period influences the susceptibility of plants to PAN and ozone. It has been found that an interaction of light, PAN, and plant tissue is essential for inducing damage. For ozone damage to pinto bean primary leaves, light is not required. A survey of the data regarding stomatal opening, and oxidant damage indicates that stomates must be open during exposure for damage to occur. However it is stated that stomatal opening and oxidant damage are not correlated. The sugar content of leaves may affect ozone susceptibility. A high sugar level protects by osmotic effects and closing of the stomates; a lower sugar level protects through a mechanism independent of stomatal operation. It has been found that ozone may damage cells by destroying the semi-permeability of the membranes. The effects of ozone and PAN on growth and metabolism, on photosynthesis, and on plant enzymes are also discussed in detail.
Source: 1

#445

Dunning, J.A., and W.H.Heck. "Response of pinto bean and tobacco to ozone as conditioned by light intensity and/or humidity." Preprint, Air Pollution Control Office, Raleigh, N. C., Ecology Branch and Agricultural Research Service, Raleigh, N. C., Plant Science Research Div., 29 p. (1971).

The effects of interactions between humidity and light intensity during growth and/or exposure on the response of a sensitive plant to ozone was studied. Pinto bean and tobacco were grown using two light intensities (2000 and 4000 ft-c) and two day humidities (60 and 80%). Plants from four combinations of these variables during pre-exposure growth were then each exposed to the same four combinations during exposure to 40 pphm ozone for one hour for a total of 16 treatments. Percent injury to the bean primary leaves and to all tobacco leaves was determined three days after exposure. The results show that the conditions under which plants are grown and exposed have a major influence on the response of the plant to an acute dose of ozone. Changes in sensitivity can be related basically to the effects on stomatal action and the cellular chemistry of the exposed plants. Most changes in sensitivity that occur at time of exposure are probably related to the stomatal apparatus while changes in sensitivity affected by varied growth conditions are more likely due to chemical changes within the plant. A significant interaction between growth light and growth humidity was observed for the pinto bean.
Source: 1

#1063

Dunning, J.A., W.W. Heck and D.T. Tingey. "Foliar sensitivity of pinto bean and soybean to ozone as affected by temperature, potassium nutrition and ozone dose." Water, Air, Soil Pollut., 3(3):305-313 (Sept 1974).

Pinto beans and soybeans were exposed to ozone to determine the interactions of growth temperature, exposure temperature, potassium nutrition, and doses of ozone on their foliar sensitivity. Pinto beans developed more foliar injury than soybeans. Pinto beans were most sensitive when grown and exposed at 28 C. Growth and exposure temperature interacted in the development of foliar injury on pinto beans, but only growth temperature influenced the amount of foliar injury on soybeans. Both species developed more foliar injury when grown with low potassium nutrition. There was no relationship between foliar injury and reducing sugars or the sucrose content of the leaves.
Source: 1

#1062

Dunning, J.A., D.T. Tingey, and W.W. Heck. "Foliar sensitivity of legumes to ozone as affected by temperature, potassium nutrition and dose." Preprint, Environmental Protection Agency, Research Triangle Park, N.C., Div. of Ecological Research and Environmental Protection Agency, Research Triangle Park, N. C.,Plant Science Research Div., 22 p. (1972). (North Carolina Univ. Agricultural Experiment Station Journal Series, Paper 3931).

Pinto beans and soybeans were exposed to ozone to determine the interactions of growth temperature, exposure temperature, potassium nutrition, and doses of ozone on their foliar sensitivity. Pinto beans developed more foliar injury than soybeans. Both species were more sensitive when grown and exposed at 28 C than at 20 C. Growth and exposure temperature interacted in the development of foliar injury in the pinto bean, but only growth temperature affected the amount of injury in the soybean. Both species developed more foliar injury when grown with low potassium nutrition. Foliar injury and reducing the sugars or sucrose content of the leaves were not related.
Source: 1

#446

Dybczynska, K. "Luft fororening hot mot polska skogar." [Poland's forests hit by air pollution]. Tek Tidskr. 101(20):30-31 (Dec. 1971).

Gaseous emissions amount to about three million tons yearly in Poland, with sulfur dioxide predominant. Precipitation adds 100 kg of sulfuric acid to one ha yearly. Dust is emitted in an amount of five million tons/yr. Forests near industrial areas are attacked by sulfur dioxide and nitrogen gases. One half of all trees are more or less seriously damaged in a total forest area of 300,000 ha which accounts for 3.5% of the total forest area. Thermal power plants consuming coals with 0.5-4% sulfur represent a major danger. Chemical plants, emitting primarily sulfur dioxide, pollute the air in a radius of 15 km, 500 ha of forest was destroyed, 700 ha damaged, and 4000 more ha affected by a chemical plant producing nitrogen-containing fertilizer, for example. The metallurgic industry is the source of 7% of the total SO2 emission, and dust and metal fluorides emissions are not negligible. While there are no resources available, a law for the protection of the atmosphere was enacted in 1966. In the period from 1971 to 1975, an increase of investments for pollution control by 150% is planned.
Source: 1

#1862
Dybezynska, K. "En godselmedelsindustris kvavefororeningar." (Effects of nitrogen compound emissions from a nitrogen fertilizer manufacturing plant in the environment." Text in Swedish. Kem. Tidskr., 3:30-32 (1972).

Forest damages caused by nitrogen compound (ammonium nitrate dust and nitrogen oxides) emissions from a nitrogen fertilizer manufacturing plant in Pulaway (Poland) are described. The yearly plant output of nitrogen is 700,000 tons. The chief pollutants, in annual amounts, are ammonia (over 2000 tons), NO_x (about 4000 tons, expressed as nitrogen pentoxide), ammonium nitrate dust (about 6000 tons), urea dust (about 2000 tons), small quantities of hydrogen, nitrogen, methane, hydrogen sulfide, and carbon monoxide, 30,000 tons of sulfur dioxide, and about 17,000 tons of fly ash from the power plant. Although the total annual deposit is below the limit value with less than 250 tons/sq km, i. e., 2.2-7.0 t/sq km of sulfates, 1.2-24.4 t/sq km of ammonia and 0.3-20.0 t/sq km of nitrate, the forests, chiefly conifers, surrounding the plant are seriously damaged. The maximum nitrogen oxides concentration is 0.6 mg/cu m. Three different zones of damage around the plant are distinguished; total damage within a radius of about 2 km, serious damages within about 4 km, and partial damages within 15 km. A forest area of 1000 hectare, where a minimum deposit of 0.8 t/sq km/yr was measured. sustained damages of 30-70%, while a minimum of 1.1 t/sq km/yr in another area caused more than 70% damage. The aerosols caused plasmolysis on leaves and other parts of the plants; the damages were due to the toxic effect on the assimilation apparatus rather than to the increased intrate transfer. The recultivation of the damaged forest was not possible, but a certain equilibrium was maintained by means of definite crops.
Source: 1

#1856
Dziubek, T. "O ujemnych skutkach pylow fabrycznych na roslinnosc i organizmy zwierzece." (Harmful influence of industrial dusts upon plants and animal organisms.) Text in Polish. Zesz. Probl. Postepow Nauk Rolnicych (Warsaw), 74:195-197 (1967).

Contamination of the atmosphere near aluminum and copper foundries and phosphate fertilizer plants is caused mainly by fluorine compounds. The contamination damages plants, meadows, and pastures adjacent to factories or situated in the vicinity and has an indirect effect on domestic animals fed with fodder from such grasslands. Grassland vegetation 100-3000 m from the factories were investigated by measuring the quality and quantity of dust; 0-30% mg% fluorine compounds were found. Changes in cattle tissue (teeth and bones), a decrease in lactation, and a stunting of young animal growth were noted. A considerable decrease in the hemoglobin in the animals investigated also occurred.
Source: 1

#447
Ebaugh, W.C. "Gases vs solids: An investigation of the injurious ingredients of smelter smoke." J. Am. Chem. Soc., 29(7):951-970 (July 1907).

The relative effects of sulfur dioxide and flue dusts in smelter smoke upon vegetation were investigated in the Salt Lake City area to assess the damages due to emission from lead and copper smelters. The concentrations of SO2 were monitored, and the effects of free SO2, sulfuric acid, SO2 in aqueous solutions, and dilute solutions of H2SO4 were individually examined. Flue dust samples were analyzed for percent content of moisture, sulfur trioxide, iron, copper, insolubles (silicon dioxide), lead, arsenic, and zinc. Many repeated applications of SO2 in concentrations present in the air of a smelting district were needed to cause injury, the degree of which was dependent on humidity. Solutions of H2SO4, if present to the extent of 1.38 g/l or stronger, caused marked corrosion. Solutions of flue dusts sprayed upon plants resulted in very severe corrosion. Soil mixtures containing 20% of the flue dust, when applied to plants, also caused very bad corrosion. Source: 1

#1064
Eda, Shizno, Hiroshi Hikichi, Hiroshi Itoh and Yoshiichi Funayama. "Sanmai no jukinzoku osen to dojo oyobi osengen to no sokansei ni tsuite." (Heavy metal pollution of rice and vegetables in relation to the soil and the pollution source). Fukushima Kogyo Koto Senmon Gakko Kiyo (Mem. Fukushima Tech. Coll.), 8(1):90-97 (1972).

Atomic absorption spectrometry was used to measure the amount of heavy metals in rice and other vegetables in an investigation of the relationship of vegetables in an investigation of the relationship of vegetable metal content to metal pollution of the soil and the pollution source. Heavy metal concentrations generally increased in rice with increasing amounts in the soil. Maximums of 3, 6, and 35 ppm were obtained for cadmium, copper, and zinc, respectively, in rice. The relation of heavy metal pollution source showed the same tendency as metal pollution of the soil with respect to the source. Source: 1

#1065
Edmunds, G.F.,Jr., and R.K. Allen. "Comparison of black pine leaf scale population-density on normal ponderosa pine and those weakened by other agents." Proc. Int. Congr. Entomol., 10th, Montreal, Canada, 1956, Vol. 4, 1956 (1958).

A study of an infestation of black pine leaf scale, on ponderosa pine revealed a direct correlation between the degree of damage to the tree and the population density of the scale insects. Tests of the hypothesis that the scale insects more readily attack trees damaged and weakened from other sources revealed the following: significantly lower average scale population density was noted on trees damaged by boron compounds used as weed killers than in

trees not so damaged; no significant difference in average population density was noted between trees with moderate needle tip dieback, presumably caused by uptake of atmospheric fluorides, and trees not showing such damage; no significant difference was found in average scale population density between those trees with relatively high fluoride content and those with relatively low fluoride content; and no difference in average population density of black pine leaf scale was noted between trees damaged by infestations of dwarf mistletoe and trees not so damaged. Hence, damaged and presumably weakened trees are concluded to be no more suceptible to attack than trees not so damaged.
Source: 1

#139

Edmonds, R. L., and C. H.Driver. "Dispersion and deposition of spores of Fomes annosus and flourescent particles." Phytopathology, 64:1313-1321 (1974).

Fomes annosus, spread by airborned spores is an important pathogen in intensively managed conifer forests. This study examined dispersion and deposition patterns of conidia and fluorescent particles in relation to meteorological conditions. Experiments were conducted on 60x60m sampling grids in a cleared area, at the edge of a 20-m-high Douglas-fir forest, and in the forest. Particles and spores were trapped with Rotorod samplers at heights of 1, 5, 10, 15, and 20 m. Deposition of fluorescent particles was determined on petri plates set 30 cm above the forest floor, simulating major infection courts. Wind speed and direction and temp were measured. Fluorescent particles generally dispersed in a similar manner to conidia. Horizontal and vertical dispersion was greater at night in the forest than in the cleared area, but this was reversed during the day. Dispersion was also affected by vegetation density with plumes being moved around areas of high density. Deposition in the forest was lower at night and higher during the day than deposition in the cleared area. At the forest edge at night, deposition was heavy due to local turbulence. Airborne concns were predicted with a dispersion model within a factor of two of observed, but deposition patterns were not reliably predicted. Natural spore deposition rates ranged from 0.0003 to 0.007 spores per cm^2 per h with the maximum occuring at night on a sampler close to the forest edge.
Source: 7

#159

Ekern, P.C. "Direct interception of cloud water on Lanaihale, Hawaii." Soil Sci. Soc. Amer. Proc., 28:419-421 (1964).

Lanai, a relatively dry island, lies in the trade wind flow downstream from Maui and Molokai and is peculiarly adapted to a demonstration of the amount of water that can be gathered by direct interception from clouds. An observation station was established at the 2,750-foot level on Lanaihale in July 1955, and maintained for 3 years. The water collected over the 3 years by a network of rain gauges set beneath a Norfolk Island pine tree averaged 391 inches while rainfall in the open was only 149 inches. Since the tree also intercepted some rainfall, a net of 30 inches is suggested as the annual gain from cloud water interception. A wire harp kept oriented into the wind

by a vane gathered 1,706 inches of water while rainfall alone was 97 inches. the harp had a vertical silhouette 27.5 times the area of the standard rain gauge in which the catch was measured. A 15- to 20-inch gain per unit vertical area exposed is suggested as the annual direct cloud interception by the harp. Identical catchers of aluminum louver mounted at several elevations up to 30 feet above the ground gave an increased catch greater than the increase of wind with elevation.
Source: 7

#449

Eichorst, E., and K. Garber. "Mikroskopische und mikrochemische Untersuchungen im Rahmen der SO_2 Raushechachendiagnostik." (Microscopic and microchemical studies within the framework of SO_2 smoke damage diagnosis). Translated from German. Mikroskopie, 25:237-242 (1969).

Corrosions on leaves caused by acid smoke of factories and the anatomical changes of cells are described. Corrosions caused by soot and sulfuric acid in experiments are compared with corrosions observed in industrial areas. Application of the Bredemann and Radeloff method to detect sulfur dioxide in in leaves by precipitation of barium sulfate demonstrated that SO_2 is often present in leaves far away from factories, since air in wide areas contains SO_2. Better results can be obtained by determining the content of sulfate in leaves. The results of the qualitative method agree with the results obtained by quantitative analysis of plant material.
Source: 1

#1066

Eller, B.M. "Strassenstaub heizt Pflanzen auf." (Street dust heats up plants). Umschau Wiss. Tech., 74(9):283-284 (1974).

Traffic in urban streets gives rise to a heavy load of dust on nearby plants. Absorptivity of solar radiation for wavelengths from 750 nm-1350 nm by plant leaves is changed toward greater values and leads to the possibility of heat stress. This influences productivity and thus vitality of such plants. Periods with rainy days and snowfall have some cleaning effect, but leaves, cleansed by washing with water show restitution of disadvantageous dust within some days. Raised values of reflectivity for wavelengths from 400 to 750 nm tends to lower photosynthesis.
Source: 1

#1067

Engelbrecht, Abraham H.P. and C. Wynand Louw. "Hydrogen fluroide injury in sugar-cane: some ultrastructural changes." Proc. Int. Clean Air Congr., 3rd, Duesseldorf, West Germany, A157-A159 (1973).

Mature sugar-cane plants were fumigated with controlled amounts of hydrogen fluoride and subsequently microscopically examined for ultrastructural changes. The first symptoms appeared as a fine stippling followed by irregular chlorotic mottling of the leaf margins and tips. These yellow

chlorotic areas became necrotic and changed from yellow to brownish-red to dark brown, followed by a complete collapse of the mesophyll cells in the necrotic areas. First symptoms appeared after exposure to 12.9 micrograms/cu m HF; acute symptoms appeared at 23.0 micrograms/cu m; and severe necrotic symptoms and ultimate collapse occurred at a concentration of 105.0 micrograms/cu m. There was an overall decrease in the size of the chloroplasts and membrane system during the development of the chlorotic fluoride injury symptoms and an increase in the size and number of osmiophilic globules. The middle lamellae were swollen and became densely stained. The tonoplast disappeared during the change from reddish-brown to dark brown, and there was a separation of the primary cell walls at the middle lamellae. The plasma membrane disappeared in the necrotic condition, and the ground plasma was very granular. The chloroplasts were smaller than in the dark brown condition, and the internal membranes as well as the plastid envelope started to disintegrate. Ribosomes were still present in the stoma, and the mitochondria were still intact.
Source: 1

#327
Endelman, F. J., M. L. Northup, D. R. Keeney, J. R. Boyle, and R. R. Hughes. "A systems approach to an analysis of the terrestrial nitrogen cycle." J. Environ. Syst., 2(1):3-19 (March 1972).

A progress report on a systems approach to the analysis of the terrestrial nitrogen cycle is presented. A mathematical model is being built to analyze and evaluate the role played by soil drainage in the nitrate pollution of groundwater water supplies and the euthrophication of the natural waste systems. The model will predict, quantitatively, the effects of nitrogenuous fertilizers and of changing land use patterns. The approach is general enough to be useful to analyzing many environmental systems. The systems analysis method is described, and the terrestrial nitrogen cycle which is the basis of the ecosystems to be studied is defined. The framework and basis of the mathematical analysis are described, and some details of the modeling and experimental studies of the soil physics and soil chemistry involved are included. The absorption of nitrogen compounds by plants is mentioned.
Source: 1

#328
Ender, F. "The effects of air pollution on animals." Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 245-254 (April 22-27, 1968).

The most important problem concerning damage to animals by air pollution is the poisoning of domestic animals by fluorine in smoke, gas, or dust from various industries. The extent of the problem is illustrated by evidence from the International literature and studies conducted in Norway, where the postwar growth in aluminum production has produced a tremendous rise in livestock fluorosis. The total quantity of fluorine in gases emitted by an aluminum plant

is roughly 20 kg/ton of aluminum produced. Emitted with the smoke and other damaging compounds such as gaseous hydrofluoric acid and fluosilicic acid, dust-containing cryolite, and aluminum and calcium-containing fluorides. The geographic location as well as topgraphic conditions near the aluminum factories have a striking influence on the fluorine contamination of soil and vegetation in the surroundings. The risk of fluorine injuries in neighboring valley districts is far greater with factories located at the bottom of deep, narrow, U-shaped valleys than with those on open, unsheltered ground. Despite installation of gas purification procedures, it is impossible to completely prevent the escape of fluorine-containing gasses from doors, ducts, and windows in electrolysis halls. With respect to the de-fluorination of forage, good results have been obtained by treating contaminated grass with a mixture of diluted sulfuric acid and hydro-chloric acid, or by using formic acid.
Source: 1

#980
Endow, N., G.J. Doyle and J.L. Jones. "The nature of some model photochemical aerosols." J. Air Poll. Control Assoc.,13:141-147 (1963).

The evidence from infrared spectra of precipitated model aerosols formed by the photo-oxidation of lower olefin homologs - nitrogen oxides - sulfur dioxide mixtures at 50% relative humidity indicated that the principal constituent of the aerosol was sulfuric acid. Other analytical data - micro-chemical elemental analysis, spot tests, and the like gave support to the belief that the principal constituent of these aerosols was sulfuric acid. In addition to sulfuric acid, the aerosols contained a smaller concentration of nitrite-type material. Weight loss studies of precipitated aerosols indicated either that portions of the condensed aerosol materials were volatile or that the aerosol was unstable and a decomposition product was volatile.
Source: 5

#981
Engelmann, R. J. "The Calculation of Precipitation Scavenging." Meteorology and Atomic Energy. D. H. Slade, editor, U.S.A.E.C. 68-60097. (1968).

Chamberlain's predicted washout coefficients in rain for particles larger than 1 μ in diameter (Fig. 5.9) are considered to be slight overestimates. In the case of particles smaller than 1 μ, it is generally agreed that wash-out by rain is insignificant. This theory cannot be considered reliable for smaller particles, however, owing to uncertain electrical effects, and quantitative measurements of this washout are not yet available.

The washout of reactive gases can be predicted by using the theory of molecular diffusion to waterdrops. Newly calculated washout coefficients based on measured rain spectra rather than on fitted spectral equations are presented and recommended (Fig. 5, 11). The prediction of washout of gases by snow must rely upon a few measurements for bromine and iodine gas since there are no theoretical predictions. In all cases the reaction of the gas with the rain or snow must be considered.

Snow apparently has about the same to three times the effectiveness of rain at the same precipitation rate for both washout and rainout of particles. However, definitive measurements are greatly needed.

Research is still inadequate on many of the complex in-cloud scavenging processes. Formal mathematical predictions of rainout due to various mechanisms are interesting but not decisive. It is therefore recommended that simultaneous measurements of contaminants in air and precipitation (e.g., Table 5.14) be used for prediction of rainout.

The manner in which the washout coefficient Λ, and the ratio of surface air to precipitation activity, x_o/k_1, vary with storm and cloud type is unknown. Therefore recommended values of Λ and x_o/k_1 may be directly combined with precipitation rates to predict scavenging rates.
Source: 5

#1068

Engle, R.L., and W.H. Gabelman. "The effects of low levels of ozone on pinto beans, Phaseolus vulgaris L." J. Am. Soc. Hort. Sci., 91:304-309 (1966).

The effects of low levels of ozone on Pinto beans were investigated. Fourteen day old Pinto beans (Phaseolus vulgaris L.) were fumigated continuously from 1 to 5 days with .05 ppm ozone. The unifoliate leaves after 3 days of fumigation exhibited premature senescence. This effect was not increased by longer fumigation. Lateral buds in the axils of the unifoliate leaves were stimulated to elongate, whereas the leaves were reduced in size and weight. Avena colcoptile straight growth tests were made to test the possible relation of the presence of auxin like material to the premature leaf senescence and bud elongation. Although definite auxin like activity was observed, the data did not suggest a mechanism for premature senescense of the unifoliate leaves or the elongation of buds.
Source: 1

#448

Engmann, F., H.G. Daessler, and S. Boertitz. "Untersuchungen ueber Huettenrauchschaeden au landwirtschaftlichen Pflanzen mit Hilfe von Feldversuchen." (Field experiments on the damage to agricultural crops caused by crystalline arsenic). Text in German. Arch Pflanzenschutz, 5(3):189-196 (1969).

Reduced crop yields caused by toxic substances in the soil originating from steel plant emissions may be compensated for by appropriate fertilization. In field experiments, the combination of buna lime and nitrogen fertilizer improved soil conditions deteriorated by arsenic. When increasing the yields through fertilization in areas damaged by crystalline arsenic, an increased occurrence of forage damaging to health must be considered. Crops susceptible to steel plant emissions include barley, clover, flax, and peas; they cannot be grown in the immediate vicinity of the emission source. This implies a disturbance of crop rotation, and consequently the possibility of further yield reductions. The test results cannot be generalized since they were obtained under particularly favorable climatic conditions.
Source: 1

#9

Environmental Protection Agency. "Effects of sulfur oxides in the atmosphere on vegetation." Nat'l Environmental Research Center, Research Triangle Park, N.C., Report No. EPA-R3-73-030 (September 1973).

This document is a review article based upon available literature. It summarizes current scientific knowledge of the air pollution effects by S oxides on veget. The following topics are discussed:

- symptoms of the effects of SO_2 on vegetation including visible, subtle and physiological effects.
- the chemical mechanism by which plants are injured.
- factors affecting the response of vegetation to SO_2 including environmental and genetic factors.
- assessment of the economic impact of SO_2.
- effects on lower organisms.
- precipitation of acid, e. g., H_2SO_4.
- vegetation as a SO_2 sink.
- dose injury relationship of SO_2 to vegetation response.

Source: 8

#1486

Eriksson, E. "The yearly circulation of chloride and sulfur in nature: Meteorological, geochemical and pedological implications. Part I." Tellus (Uppsala), 2(4):375-403 (Nov. 1959).

The circulation of airborne oceanic constituents is discussed. About 1000 million tons a year are produced and about 90% is precipitated over the ocean. The rest is carried into continents and is brought back to the sea in rivers. A major part of the sulfur in the atmosphere is of oceanic origin, but does not originate as chloride through spray emitted from breaking waves. The release of hydrogen chloride from sea salt particles due to absorption of oxidized sulfur dioxide is quantitatively important and mainly responsible for variations in the chlorine/sodium ratio in precipitation. The deposition of chloride in precipitation over continents indicates the main areas of inflow of maritime air. Sea salts are carried to the ground from the air at a rate of 1-2 cm/sec. This agrees with the turbulent nature of air close to the ground. The reduction of sulfur in groundwater can cause precipitation of calcium and magnesium which modifies the chemical properties of groundwater considerably. The role of airborne sea salt components for the development and properties of soils is discussed.

Source: 1

#1487

Eriksson, E. "The yearly circulation of sulfur in nature." J. Geophys. Res., 68(13):4001-4008 (July 1 1963).

Though the circulation of sulfur in nature is more complicated and extensive than was realized earlier, it is possible to represent it in a semiquantitative way. The total amount passing through the atmosphere is 365 millions tons/yr. The industrial emission at present makes up only 11% of the total. Sulfur lost in precipitation need not balance all of the sulfur that is brought into the atmosphere from various sources, because absorption by soils and plants takes place. Industrial sulfur precipitation over land need not show up in river water. After precipitation it may be released by hydrogen sulfide and carried out over the oceans before being reprecipitated into a different form. River-water sulfur, weathering and fertilizer sulfur, precipitation, dry depositon of sulfur, biological turnover of sulfur in the sea, and sedimentation of sulfur in the sea are parts of the circulation pattern of sulfur. The importance of the biosphere, both the oceans and on land, is that the circulation of sulfur that yearly passes through the atmosphere seems to be about ten times as great as industrially released sulfur.
Source: 1

#329

Ermarkov, V.V., and V.V. Kovalskiy. "Biologicheskoye znacheniye selena: selenoviye endemi." (The biological significance of selenium: selenium endemic diseases). Translated from Russian. Leo Kanner Assoc., Redwood City, Calif. 40 p., May 1971. Usp. Sovrem. Biol., 65(2):267-284 (1968).

Selenium influences cell growth and mitosis in organisms. There is a functional antagonism between sulfur and selenium, and under certain conditions selenium replaces sulfur in its organic compounds. The biochemical functions of selenium, on the strength of its physiochemical characteristics and its small amount in organisms, must lie in its role as catalyst. The effect of additions of selenium to the rations of animals is discussed. The interest and relationship of selenium with the processes of phosphorylation are described. The parallelism in effect between selenium and vitamin E is not clear with the exception of their common antioxidant behavior. The favorable therapeutic effect of small amounts of selenium in white sac sickness, its inhibiting of cell growth and capacity to protect biological systems from radiation are examined.
Source: 1

#1069

Ernst, Wilfried. "Zink- und Cadmium-Immissionen auf Boeden und Pflanzen in der Umgebung einer Zinkhuette." (Zinc and cadmium pollution of soils and plants in the vicinity of a zinc smelting plant). Ber. Deut. Bot. Ges., 85(7-9):295-300 (1972).

The airborne zinc and cadmium pollution of soils and plants around a zinc smelting plant was studied. Accumulation of both zinc and cadmium in plants and soils by factors of up to 100 was determined. Exposure to zinc and cadmium containing dust for 3 consecutive years resulted in the death of such plant

species as Pinus silvestris L., Juniperus communis L., Acer platanoides L., Quercus robur L., Malus communis Mill., and in partial damage of Carpinus betulus, Tilia platyphyllos, Taxus baccata, Aesculus hippocastanum, and Betula alba. The rates of penetration of cadmium and zinc deposited on the leaves amounted to over 90% and 12.5-31%, respectively. Most of the cadmium and zine were found in insoluble or soluble form in the cell wall which is indicative of a limited metabolic activity of these heavy metals. The zinc and cadmium levels were above the normal value in soils at distances of up to 3.5 km from the smeltery. Following cultivation in contaminated soil for 8 weeks, Silene cucubalus L. accumulated 4500 mg zinc and 32.7 ml cadmium per kg of dry matter. Zinc substantially reduced the dehydrogenase activity and the microbial nitrogen mineralization process in the soil.
Source: 1.

#70

Eschenroeder, A. Q. "Survey of the state of knowledge of sources of naturally emitted reactive hydrocarbons into the atmosphere." Pub. General Research Corp., CA. 27 p. (September 1974).

In this report the present scientific state of knowledge is reviewed for sources of naturally emitted reactive hydrocarbons. The literature is surveyed first to determine current thinking on the origins and natural emission rates of these reactive hydrocarbons compared with anthropogenic emission rates of the same classes of hydrocarbons. Measurements of atmospheric concentrations in remote areas are cited and atmospheric reaction mechanisms are explored in an effort to characterize the transformation and fate of these hydrocarbon sepcies. In conclusion, both the state of knowledge of emission rates and that of atmospheric levels and processes are evaluated. Finally, preliminary recommendations for future work are made for further measurements covering oxygenated hydrocarbon compounds and analysis of the reactive diffusion of compounds from plant-covered areas of the earth's surface. The recommended analysis can be done using available data to test the internal consistency of various measurements that have been reported in the literature. This could be done using existing techniques.
Source: 8

#1070

Eshleman, A. and S.M. Siegel. "Metals in the ecosystem, leaded grass and other abominations." Hawaii Univ., Dept. of Botany, Honolulu, 10 pp. (1970).

In Hawaii, the source of lead pollution is almost entirely the burning of leaded motor fuel, and since island soils in their natural state have a low lead content, it is possible to construct model biogeochemical lead cycles using a pollution aerosol as a starting point. It is known with certainty that these aerosols transfer at least some of their lead to soils from which plants take it up, probably through the root system. Lead deposited from pollution aerosols seems to be confined to the upper few centimeters of soil surface, while the amount of organic matter in the soil apparently affects the quantity of lead taken up by plants. Laboratory results strongly suggest that lead may be concentrated through the decay process. The ingestion of lead is briefly discussed in relation to the fatal poisoning of animals pastured on leaded grass, intake through food in urban dwellers, possible transport of lead across the human placenta, and nesting failures of a marine bird species. The subtlety of the biological effects of environmental lead and the intrinsic toxicity of the element indicate that it is far more hazardous and merits far more attention than the more familiar classes of air pollutants.
Source: 1

#977
Evans, L.S. "Bean leaf growth response to moderate ozone levels." Environ. Pollut., 4(1):17-26 (January 1973).

The middle leaflet from the first trifoliate leaf of pinto bean plants was subjected to various ozone levels for 12 and 24 hr to determine oxidant injury. Rates of leaf expansion were used as criteria to measure the effects of ozone at three leaflet positions. Growth analysis included Y-intercepts indicating growth after day 1, growth after day 3, and regression line slopes between days 1 and 7 after the beginning of exposure experiments. Slopes of growth rate regression lines differentiated untreated leaflets from leaflets exposed to an 0.60 ppm/hr dose (0.05 ppm for 12 hr). Growth rates of plants exposed to 1.20 ppm/hr (0.05 ppm for 24 hr or 0.10 ppm for 12 hr) were distinguishable from untreated plants within three days. Basal leaf portions indicated the most differential ozone response compared with lateral and tip positions.
Source: 1

#1291
Evans, L.S., and P.R. Miller. "Comparative needle anatomy and relative ozone sensitivity of four pine species." Can. J. Botany, 50:1067-1071 (1972).

Relative ozone sensitivity was evaluated according to morphological and histological characteristics in four pine species grown in containers under greenhouse conditions in California's San Bernardino National Forest. The secondary leaves of the more ozone-sensitive species exhibited a larger number of stomata per cross-sectional area of mesophyll cells, while the number of mesophyll cells per stomata was lower. The number of hypodermal layers and thickness of the epidermal and hypodermal layers was negatively correlated with ozone sensitivity. In more ozone tolerant pine species, initial injury was more closely associated with substomatal mesophyll cells. Ozone injury affected a greater proportion of the entire needle of the sensitive species as evidenced by histological symptoms closer to the needle base.
Source: 1

#451
Evans, Lance S. and Paul R. Miller. "Ozone damage to ponderosa pine: A histological and histochemical appraisal." Am. J. Botany, 59(3):297-304 (1972).

Experiments were conducted to observe and identify the early histological and histochemical effects of ozone injury in Pinus ponderosa needles and to provide an additional diagnostic procedure. Clonal plant material was obtained by grafting branchlets from a single, sensitive ponderosa pine on ponderosa seedlings in containers, which were then subjected to carefully monitored amounts of an ozone-air mixture. Fifteen, 20 and 30 micron slices from various parts of the leaf were stained and examined. Carbohydrates, proteins, nucleic acids, pectins, calcium, and two enzymes were localized histochemi-

cally. The plicate mesophyll cells were most sensitive to ozone fumigation, showing various degrees of damage in different parts within the cell. The walls of the mesophyll cells were abnormally folded and twisted following chloroplast aggregation. Histochemical assays revealed further ozone damage related to changes within the mesophyll cells. Cell damage appears to begin in the median abaxial portions of the leaf and eventually spreads throughout the leaf. Visible symptoms appeared 2-3 weeks after the start of fumigation, while histological and histochemical assays revealed ozone injury within 5 days.
Source: 1

#450

Evans, L.S., and I.P. Ting. "Ozone-induced membrane permeability changes." Am. J. Botany, 60(2):155-162 (1973).

The effect of 0.5 ppm ozone for 0.5-1 hr on plant cell membrane permeability was ascertained. Permeabilities to both water and solutes were estimated by measuring leaf disc weight changes and following tritiated water and rubidium-86 fluxes. Measurements were made immediately and 24 hr after O_3 exposure. The reflection of coefficient, an index solute permeability, decreased in O_3 ozone-treated primary leaves of pinto bean. The latter indicates an increase in membrane solute permeability of internal solute leakage. Water and tritiated water flux estimates both indicated a decrease in membrane permeability to water; both the hydraulic conductivity and the water diffusional coefficient apparently decreased, an anomaly which is discussed. These data indicate that ozone has a direct effect on membrane function by altering permeability characteristics. Thus, cell membranes are primary target sites for ozone injury.
Source: 1

#992

Evans, L.S., and I.P. Ting. "Effect of ozone on 86 RB-labeled potassium transport in leaves of Phaseolus vulgaris L." Atmos. Environ, 8(8):855-861 (Aug. 1974).

The effect of ozone on 86-rubidium labeled potassium transport in the leaves of the bean. Phaseolus vulgaris was investigated. At low K concentration (below 0.2 mM) in the light, O_3 decreased K uptake of bean leaf discs mimicking the effect of dark and dinitrophenol. At high K concentration (from 0.4 mN to 0.1 M) in the light, O_3 caused a more marked uptake reduction than dark treatment. The reduced uptake did not parallel or mimic dark treatments at low K levels. Ozone possibly reduced the energy sources for uptake at low K concentration. At high K concentration a general K, and possibly a general cation leakage may be present. Low levels of O_3 (0.5 ppm for 1 hr. which does not cause visible injury) result in reduced K uptake and accumulation in bean leaf discs.
Source: 1

#1975
Everett, M. D. "Roadside air pollution hazards in recreational land use planning." Air Journal (1974).

Convincing evidence points to the deleterious effects of air pollution on the health of general populations. Increased morbidity rates from lung cancer, stomach cancer, emphysema, and other respiratory diseases have been noted for populations in highly polluted areas. Persons engaging in recreational activities near major concentrations of automobile traffic are probably subjecting themselves to particularly high levels of air pollution. The more vigorous the recreational activity the more hazardous may be the effect of the pollution. It is important that planners take these factors into account when making recreational land use decisions.
Source: 8

#1292
Ewert, E. "Die Einwirkung von Chlorwasserstoff auf Pflanzen im Experiment." (The effect of hydrochloric acid on plants in experiments). Polska Adademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzymarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland. 197-208 (Sept. 9-14, 1968).

The damaging effect of hydrochloric acid on test plants was examined in connection with damage to vegetation in areas near chemical and potassium factories. Tents of transparent, thin polyethylene sheet about 2.8 m long, 2.0 m wide, and 1.0 m high were used as gastight enclosures, in which up to 25 plant pots could be accomodated for each experiment. Agricultural and forest plants were exposed to test gas mixtures with hydrochloric acid concentrations from 0.05 mg/cu m to 2.0 mg/cu m, for test periods between 50 and 470 hours. Visible damage occurred primarily at the tips and edges of leaves and needles in the form of brown necrosis. Under conditions of intermittent gassing no damage occurred when the maximum permissible emission concentration of 0.05 mg/cu m was not exceeded. The tested plant varieties were divided into three groups according to their sensitivity to HCl. At a concentration of 2.0 mg HCl/cu m, leaves of beans or peas showed the first symptoms of necrosis after eight hours. If removed from the test enclosure at that stage, the damaged leaves usually died off, but three to four weeks later new, undamaged leaves were produced by the plant. With the same concentration and an exposure of about 100 hours, all plants tested died. When exposed continuously, the test plants accumulated chloride in concentrations of up to 2% of the dry leaf material, equivalent to about 20 times the chloride content found in normal undamaged plants of the same type.
Source: 1

#452
Faller, N. "Plant nutrient sulphur-SO2 vs SO4." Sulphur Inst. J., 7(2):5-6 (Summer 1971).

Although it was demonstrated that atmospheric sulfur dioxide is an alternative source of plant nutrient sulfur, it was not determined how this source compares in relative efficiency with sulfate uptake through the roots.

To compare the two sulfur sources, a series of experiments was carried out with tobacco plants. The yield obtained with SO2 as the only source of sulfur clearly indicates that this is a completely satisfactory way of supplying sulfur. The combination of atmospheric SO2 and root sulfate reduced the root yield slightly compared with the straight root sulfate treatment. However, the leaf and stem yield showed an increase, except for the highest sulfate concentration. The plants had been grown in nutrient solutions containing 0, 40, 80, and 240 ppm sulfur as sulfate. One set of test plants was transferred to closed glass cages, in which they were subjected to 1.5 mg SO2/cu m of air. Before transfer to the glass cages, the young plants grown in the control solution showed sulfur deficiency symptoms in the form of chlorotic leaves. When sulfur dioxide exposure was started, these symptoms disappeared in the first few days.
Source: 1

#32
Faller, N. "Schwefeldioxid, Schwefelwasserstoff, nitrose Gase und Ammoniak als ausschliessliche S- bzw. N-Quellen der hoeheren Pflanze." (Sulfur dioxide, hydrogen sulfide, nitrous gases and ammonia as sole sources of sulfur and nitrogen for higher plants). Z. Pflanzenernaehr. Bodenk., 131(2):120-130 (1972).

Plants were subjected to long-term exposures to sulfur dioxide, hydrogen sulfide, ammonia, and nitrogen dioxide to determine if gaseous absorption can be the only source of sulfur and nitrogen. Sulfur dioxide exerted a clear effect on plant production. The strongest action of the nutrient was on the youngest upper leaves. Most of the sulfur taken up from the air was converted to sulfate (sunflowers 92.65%, corn 85.81%, tobacco 92.57%, oil radish 91.5%). A noticeable proportion was also incorporated into the organic material (sunflowers 25.6%, corn 32.85%, tobacco 26.86%, radish 25.1%). In tests in a sulfur-free nutrient solution, SO_2 served as the sole sulfur source. In an experiment with sunflowers, H_2S-exposed plants showed normal growth, while control plants grew less and exhibited sulfur deficiency. The H_2S uptake is of lower intensity than SO_2, but this is all to the good, since SO_2 can cause too great a sulfur accumulation in the assimilatory organs. Nitrogen content of plant material increased as NO_2 content rose, and NO_2 was a sole source of nitrogen. Ammonia also ensured plant growth, not only during the development stage, but over the entire growth period. Damage to plants appeared at the highest NH_3 concentrations, however. Thus, these gases can serve as the sole source of sulfur and nitrogen for higher plants, providing normal growth during the whole duration of the experiment. Sulfur and nitrogen were taken up by the plants from these compounds and transposed to the roots. With the sulfur gases, assimilation was more intense with SO_2 than with H_2S. With the nitrogen-containing gases, the uptake was more intense with NH_3 than with NO_2.
Source: 1

#52
Faller, N. "Absorption of SO2 by tobacco plants differently supplied with sulphate." pp. 51-57. IAEA-SM-151/39. (No date).

Tobacco plants were fumigated in glass cages with 1.5 mg of SO_2/m^3 air. The sulphate concentration in the nutrient solution ranged from complete omission to a relatively high content. The gas for fumigation was tagged with $^{35}SO_2$, which made it possible to record the total absorption of sulphur from the air, transformation of the absorbed gas into other compounds and its distribution to separate organs. The plants were fumigated with SO_2, and without sulphate nutrition they showed an increase parallel with that of the plants favourably supplied by way of roots. This proves that SO_2 can be the only source of sulphur for higher plants. The total absorption of SO2 per plant, as well as per unit of leaf weight, concur in separate treatments, whereas higher concentration of sulphate did not have a negative effect, as has previously been believed. The greatest part of the absorbed SO_2 was oxidized in the plant into the sulphate form, and a smaller part was reduced and incorporated into organic compounds prevailing in the insoluble fraction. The greatest part of sulphur absorbed from the air remained in the leaves, though all the fractions were recorded in the stalk and in the root. The plants absorbed more sulphur from the optimal sulphate nutrient solution. Translocation of sulphate from the leaves into the root was insignificant, which confirms the known poor basipetal movability of this form. In contrast with the low content of the labelled sulphate form, the insoluble organic fraction is considerably higher in the root; the difference from the leaf is moderate. The smallest difference between the root and the leaf is in soluble organic compounds, which points to the established balance and to efficacious basipetal mobility. As to the varied sulphate content in the nutrient solution, there is a general decrease in the sulphur absorbed from the air in the organic fractions.
Source: 8

#28
Faller, N., K. Herwig, and H. Kuhn. "Absorption of SO_2 from the air." Plant & Soil, 33: 283-295 (1970).

Intake and absorption of S from air in individual plant organs was studied. While absorption intensity of the plant for SO_2 from the atmosphere continuously increases with its concentration and with duration of exposure, intake in the individual S fractions was not uniform. Sulfate S was enriched the most. Organically bound S experiences an increase with increasing SO_2 exposure. The ratio of acid-insoluble organically bound S to acid-soluble organically bound S decreases with increasing SO_2 treatment.
Source: 8

#780
Faller, N., K. Herwig, and H. Kuhn. "Die aufnahme von schwefeldioxyd (S3502) aus der Luft. I. Einfluss auf den Pflanzlichen ertrag." [Assimilation of sulfur dioxide (S3502) from the air. I. Influence on the plant yield]. Plant Soil, 33:177-191 (1970).

Sunflower, corn, tobacco, and radish plants were exposed to 0-1.5 mg sulfur dioxide/cu m air for 9-20 days in special vegetation chambers. Corn and sunflower reacted with 0.5 or 1.0 mg SO2/cu m air to give an optimal yield, and a rise in yield was established for radish and tobacco up to 1.0 or 1.5 mg SO2/cu m air. Under the experimental conditions, the SO2 assimilated from the air represented the predominant source of sulfur which, in general, makes possible normal plant growth. The results demonstrate that the sulfur supply from the air is of special importance for plants with insufficient nutrition in contact with plant roots.
Source: 1

#1294

Farrier, P. M., and D. R. Pullen. "Survey of fluoride levels in the area around the bluff smelter." Proc. Pollut. Res. Conf., Wairakei, New Zealand, p.341-356. (June 20-21, 1973).

The environmental control monitoring program at the Bluff Aluminum Smelter is discussed as applied to areas adjacent to the smelter. Fluorine effects on wildlife and vegetation are considered, and the background levels of fluorine in the flora, fauna, air, and water of the area are presented. The effect of smelter emissions on these background levels and the care needed when interpreting these results are also discussed. The results showed that extraneous sources of fluorine may influence the fluoride content of biological tissues and that allowance must be made for this factor in interpreting results against established standards. In particular, the effect of dressing with phosphate fertilizers was discovered. There was also a great variation in the fluoride levels in different specimen of flora and fauna. Emission of fluorides from the smelter had a small influence on the background levels in some areas, but in no instances were the standard limits to prevent damage to vegetation and livestock exceeded. No change was detected in the atmospheric fluoride levels in areas western and northern from the smelter since the smelter began operations. Levels on the eastern side (downwind) of the plant were greater, but standards are not expected to be exceeded.
Source: 1

#1293

Farrar, J. F. "Lichen Physiology: Progress and Pitfalls." In: Air Pollution and Lichens. B. W. Ferry, M. S. Baddeley, and D. L. Hawksworth (eds.), Toronto, Toronto Univ. Press, Chapt. 12, p. 238-282 (1973).

The metabolism of sulfur and its compounds by lichens is discussed. Despite the proposed sensitivity of lichens to atmospheric sulfur dioxide, very little is known about the metabolism of S compounds. Without more detailed knowledge of the way in which lichens use S and sequester it in the thallus under normal conditions, it is difficult to interpret experiments in which sulfur oxides are applied and their effects monitored by changes in some physiological parameter not obviously connected with S metabolism per se. The accumulation of S from city air by live thalli of Usnea filipendula is six times greater than that by dead thalli; both the dead thalli and cotton wool also accumulate appreciable amounts of S. Most S absorption under these conditions was metabolic, but some was non-metabolic. A review of photosynthesis and general metabolism is given. The effects of environmental variables including water, temperature, light, pH and nutrients, and seasonal variation are also discussed.
Source: 1

#1284
Fatiadi, A. J. "Effects of temperature and of ultraviolet radiation on pyrene absorbed on garden soil." Environ. Sci. Technol., 1(7):570-2 (July 1967).

Irradiation of pyrene adsorbed on garden soil for 240 hours at 32 degrees gave a mixture of products that could be separated by thin-layer and column chromatography. Eight compounds were formed, and five have been identified: 1,1'-bypyrene, 1,6-and 1,8-pyrenediones, and 1,6- and 1,8-pyrenediols. When the pyrene adsorbed on garden soil was stirred in the dark for 240 hrs. at 32 degrees, the yield of 1,1-bipyrene was lowered (from 4 to 6%) to 0.3%, and only traces of the two diones were formed; on treatment in the dark at 110 degrees for only 8 hrs, dione yields were increased to 2.5%. When other particulates (silica gel, alumnia, florisil, etc.) were used instead of garden soil, 1,1'-bipyrene was not formed. Experiments in which radical-capture agents were incorporated showed lower yields of 1,1'-bipyrene, indicating that the reaction with ultraviolet irradiation involves a free-radical mechanism. The yield of the diones was unchanged with these agents present, suggesting that they are formed by attack of adsorbed oxygen on photo-excited pyrene molecules. Irradiation of pyrene in the crystalline form without soil did not produce 1,1'bipyrene. No attempt was made to follow quantitatively the input of energy during the irradiation of pyrene on soil (a heterogeneous reaction); from the practical standpoint, however, the main objective of this study was to trace the fate of pyrene on soil, as a representative reaction of a seris of polycyclic, aromatic hydrocarbons (carcinogenic and non-carcinogenic).
Source: 1

#183
Feder, W. A. "Modifying the enivronment." Hort. Science, 5(4):247-249 (August 1970).

Measures that might be taken to protect plants from various pollutants, either by cultural manipulation or by various chemical or mechanical devices, are outlined. Complex relationships exist between temperature, humidity, light, and stomatal function. Both high and low temperatures for one or more days prior to ozone exposure reduce plant sensitivity. Plants held on the dry side are less damaged by air pollutants. Injury to irrigated crops, either in the field or greenhouse could be moderated by astute timing of irrigation cycles and close attention to soil moisture levels. Plants grown under lights in a temperature-controlled greenhouse could have their stomatal functions manipulated by varying light intensity and quality. The nutritional status of the growing plant also influences its sensitivity to pollution injury. The role of the physiologic state of the plant as it relates to air pollution sensitivity could be explored by experimentation with plant growth substances. Attempts to protect plants from air pollutants by mechanical devices and by direct application of chemicals are described. Destruction of ozone at the leaf surface can be achieved using anti-oxidants and anti-ozonates. Ozone is also destroyed by finely divided iron oxide, zeolites, silica gel, or activated carbon. To date, none of these dusts and sprays are economically feasible for full scale application. The use of activated charcoal filters for the prevention of air pollution damage is also reported.
Source: 1

#516
Feder, W.A. "Plant response to chronic exposure of low levels of oxidant type air pollution." Environ. Pollut., 1(1):73-79 (July 1970).

Clutivars of geranium and carnation exhibit a reduction of side branching, a retardation of floral initiation, and a decrease in floral productivity when exposed daily for 5-7 hr to 0.1 ppm ozone for 1-3 months. These plants also exhibit a reduction in leaf size, an increase in internode length, a progressive destruction of leaf tissue and eventual defoliation in the case of geranium. Cultivars of petunia exposed to chronic low levels of oxidant are slower to flower and bear fewer flowers than those same cultivars grown in charcoal-filtered air from the same source. These plant effects are of special interest because they occur in the presence of pollutant levels encountered daily in areas surrounding US metropolitan centres.
Source: 2

#541
Feder, W.A. "Cumulative effects of chronic exposure of plants to low levels of air pollutants." Adv. Chem. Ser., 122:21-30 (1973).

The biological effects of repeated exposure to low levels of air pollutants can be studied using green plants. Plants exposed to 10 ppm ozone over a long time show reduced growth, leaf size, stem length, root weight, and flower production, as well as a delay in the onset of floral initiation. These effects are expressed in terms of the depression of total plant growth or population growth, as distinguished from acute effects which generally cause injury to plants or plant parts but do not necessarily affect total growth or productivity. Attempts to measure the impact of air pollution on agricultural productivity must consider both the acute and the cumulative dose response relationship.
Source: 2

#648
Feder, W.A., and F. Sullivan. " Ozone: depression of Frond multiplication and floral production in duckweed." Science, 165:1373-1374 (Sept. 26, 1969).

The rate of frond doubling of Lemna perpusilla No. 6746 exposed to low levels of ozone was less than one-half that exhibited by plants growing in an environment free of ozone. Control plants showed a short lag phase after which frond numbers doubled every three days as a linear function of time when plotted on a log scale. Plants growing under conditions of daily ozone exposure exhibited a longer lag phase and frond numbers doubled about every seven days. The multiplication of ozone-exposed fronds was nonlinear in function. Floral production followed a pattern similar to frond multiplication. Flowering occurred on the 11th day in control plants and increased linearly thereafter. Flowering among plants exposed to ozone occurred after 15 days and the number of flowers increased linearly but at about one-half the rate exhibited by the control plants. Among treated plants, frond size was slightly reduced, and fronds tended to separate more readily when mature. There was a slight degree of yellowing which was not visible in untreated plants but no bleaching or other gross injury ever appeared.
Source: 1

#781

Feliciano, A. "Survey and assessment of air pollution damage to vegetation in New Jersey 1971." Rutgers - The State Univ., New Brunswick, N. J., Dept. of Plant Biology, Environmental Protection Agnecy Contract 68-02-0078, Rept. EPA-R5-72-010, 53 p. (Oct. 1972).

A survey of injury resulting from air pollution episodes and assessment of their resultant effect on crop production in 1971 was conducted in New Jersey. Three hundred fifteen reported air pollution incidences were investigated and documented during the period of the survey which was concentrated in the central and southern counties of the state. Plant injury was observed in 17 counties, but economic loss or crop damage was observed in only 16 of these counties. Over one fourth ($337,265) of the total crop losses ($1,185,800) for New Jersey were recorded in Cumberland County. The photochemical pollutants were responsible for 80% of the plant injury recorded, with ozone contributing about 60% and peroxyacetyl nitrate 20% of the total. The other pollutants involved and their percentages of plant injury are hydrogen chloride mist and chlorine gas 6%, ethylene 3%, fluoride 2%, sulfur dioxide 2%, ammonia 2%, particulates 2%, and oil, petroleum, and an unidentified pollutant 3%. Only 29 out of 70 plant species observed exhibited injury. Vegetables accounted for 51% of the total crop loss. Damage to lettuce accounted for over one third of the vegetable loss and 12% of the total estimated crops.
Source: 1

#454

Fenton, A.F. "Lichens as indicators of atmospheric pollution." Irish Nat. J. (Belfast), 13(7):153-159 (July 1960).

Lichens as indicators of atmospheric pollution were investigated with respect to studies to determine if the lichen genera could be arranged in order of their tolerance to smoke and the general atmospheric pollution of Belfast. Lichen vegetation within the actual city boundary, in open sites, and along one of the main exit roads from the city was examined. Crustaceous lichens were the most tolerant of atmospheric pollution, increasing in prevalence and species with falling values of atmospheric pollution. Foliaceous lichens only appeared when the pollution decreased somewhat and thereafter increased rapidly with increasing atmospheric purity. Fruticose lichens appeared last and were apparently the most susceptible to air impurities.
Source: 1

#453

Fenton, A. F. "Atmospheric pollution of Belfast and its relationship to the lichen flora." Irish Nat. J. (Belfast). (April 1964).

The occurrence of lichens in the atmosphere of Belfast, Ireland, are reported showing a single species of lichen Lecanora conizaeoides is the only lichen which can tolerate a high degree of atmospheric pollution such as exists in Belfast, but where smoke exceeds 20-25 mg/100 cu m and sulfur dioxide concen-

tration exceeds three pphm, it is unlikely to be found. The percentage cover of this lichen increases fairly regularly and rapidly as smoke concentration falls from 20-25 to 12 mg/100 cu m and SO2 concentration falls from 2.5 to 1.8 pphm. The percentage cover of L. conizaeoides may reach 60% or more before any other recognizable crustaceous species occur. When other crustaceous species appear the percentage cover of L. conizaeoides usually decreases. Apparently L. conizaeoides is not only tolerant of a medium smoke and SO2 level, but actually thrives in such areas. Whether the deposition of solids is of vital importance is less clear since the lichen occurs in areas where this deposition varies from 140 to over 300 tons/sq mi. Exceptionally, Candelariella vitellina is found within the L. conizaeoides zone, always on cement and lime plaster work, but it is very poorly developed and its presence may be due to favorable nitrogenous contamination. The first foliaceous lichens to appear are species of Parmelia, usually P. Saxatilis, and the estimated smoke contamination level is then below 5 mg/100 cu m and SO2 probably less than 1.5 pphm. Fruticose lichens indicate conditions of little or no atmospheric pollution though they may be present as impoverished forms at levels of smoke and SO2 concentration only slightly less than those at which foliaceous types first occur.
Source: 1

#455
Fetner, R.H. "Chromosome breakage in Vicia faba by ozone." Nature (London), 181(4607):504-505 (Feb. 15, 1958).

Root meristem cells of Vicia faba were exposed to an atmosphere of ozone and the fraction of cells showing chromosome aberrations were recorded. The cells were all exposed in interphase and analyzed at the first anaphase. The results of exposing Vicia faba seeds to 0.4 weight percent ozone for 15, 30, and 60 minutes showed that all chromosome bridges were of the chromosome type. They were the result of dicentric or centric ring aberrations. Also, x-rays were tested and the synergistic effects of ozone and x-rays were measured.
Source: 1

#1956
Fisher, H. L. "Deposition velocities of aerosols and vapors on pasture grass." California Univ., Livermore, Lawrence Radiation Lab., (TID-4500) (UX-48 (UCRL-14702) 20 pp.(March 14, 1966). CFST1: UCRL-14702.

Predictive models of vapor and aerosol particle deposition velocities on grass surfaces are presented both as equations and as paramstric curves that illustrate the relationship between the deposition velocity and such factors as wind speed, terrain roughness, and the terminal velocity of particles. Comparison is made with experimental results under known conditions and it is demonstrated that vapor deposition velocity can be predicted to within 1 factor of 3, while particle deposition velocity can be predicted to a factor of 2 or better, the accuracy increasing with increasing particle size. The deposition velocity of fallout debris has been calculated both for deposition on pasture grass and fallout collectors (pot or gummed-film) at wind speeds on the order of 10 mph. These calculations

indicate that the deposition velocity on pasture grass for vapors and small particles is approximately 3 times as great as the deposition velocity on the fallout collectors. For particles 20 microns in diameter, the calculated values are the same for both types of surfaces. Specific values predicted on pasture grass for 10 mph wind speeds are: (1) 0.5 cm/sec for fallout particles 1 micron in diameter or smaller, (2) 1 cm/sec for fallout particles 10 microns in diameter, (3) 2 cm/sec for 1-131 vapor, and (4) 3 cm/sec for fallout particles 20 microns in diameter. Since these values show substantial agreement with experimental results, they can be used for hazard calculations.
Source: 1

#1295
Fleischer, R. L., and F. P. Parungo. "Aerosol particles on tobacco trichomes." Nature (London), 250(5462):158-159 (July 12 1974).

It is possible that sub-micron aerosols may contact and be incorporated into the sticky tips of tobacco trichomes. These aerosols may contain radioactivity. During tobacco curing, the sticky exudate polymerizes to encapsulate the aerosols in highly insoluble particles. When smokers inhale smoke they may inhale these aerosols which can be deposited in the lungs. Thus, the radioactive aerosols may have long residence times in the deep lungs. To prove this hypothesis, trichomes from North Carolina flue-cured and Turkish air-cured tobacco leaves were examined for elements heavier than neon in particles down to 250A in diameter. Silicon, sodium, chlorine, calcium and potassium occurred frequently, iron and lead occasionally. Aerosols of greater than 0.5 micrion diameter were analyzed individually on the surface of trichomes. They were attached to most of the trichome tips of the North Carolina Tobacco and to half of those on Turkish tobacco. Iron, silicon, and chlorine were found in the particles, implying that the particles were silicate minerals and salt. Thus, the tips and particles on them contained elements commonly associated with both continental and marine aerosols. Previous investigations proved that radon daughter radioactivity is present in trichomes; this study showed that the aerosols which normally carry this radioactivity are present in the tips.
Source: 1

#1976
Flemer, W. "Trees in towns." Journal of the Royal Horticultural Society, 100: 22-35 (1975).

Because it is currently receiving so much deserved attention, air pollution is often blamed for the failure of newly planted street trees to survive, and for the sickly condition of older ones. Bad pollution is always a factor which contributes to the ill health of trees, but a far more prevalent cause is partial or total neglect during the very crucial first growing seasons after transplanting. In this age of science and automation, careful attention to the changing needs of newly planted trees (and these vary according to the temperature and precipitation) receives short shrift. Such sympathetic attention is the real "art" of horticulture and makes it as much an art as a science. The death of young shade trees on city streets is a costly waste of municipal funds, always in short supply. Regular examination and care in providing the basic requirement of plant life - good soil and adequate water - can reduce such tree losse almost to zero.
Source: 8

#1215
Flemming, G. "Meteorologische Überlegungen zum forstlichen Rauchschadengebiet am Erzgebirgskamm." (The air pollution affected forests in the 'Erzgebirge' mountain range relative to meteorology). Wiss. Z. Techn. Univers. Dresden (Herausbeger: Der Rektor), 13(5):1531-1538 (1964).

Wind and turbulence are the main meteorological factors in the mountain range of the 'Erzgebirge'. Their effect on the smoke distribution and the transport of smoke into the range, are explored. Important to note is the formation of inversion layers which are diffused by dynamic and thermal influences beginning at the southeastern slope of the range. The effect of stand boundaries and protective tree rows on smoke distribution are discussed. Also examined are climatic elements that have a damaging influence. Smoke particulates enrichment in fog, and in fog under frost condition, are pointed out.
Source: 6

#1130
Flemming, G. "Under what circumstances can forest belts reduce the concentration of waste gases." Luft & Kaltetechnik, 6:255-258 (1967).

According to the author, there are four effects caused by forest belts and forest fringes in the distribution of waste gases and smoke damage. These factors are reduction in wind velocity, increase in turbulence, filtering by plants, protection from wind. The main factors in regards to smoke diffusion are wind and turbulence. There are two prerequisites to be met if smoke concentration is to be decreased by a forest belt. First, the forest belt has to be located at a "higher altitude than the original level of distribution of the axis of the plume of smoke." Secondly, the forest belt must be within a certain range from the smoke immission source.
Source: 6

#1139
Forsdyke, A. G. "Meteorological factors in air pollution." WMO Tech. Note No. 114. Geneva. 32 p. (1970).

In proposing this Technical Note, the Commission for Atmospheric Sciences Working Group on Atmospheric Pollution and Atmospheric Chemistry envisaged an introductory text that would explain the basic meteorological concepts commonly used in air pollution applications for operational meteorologists, scientists and others who have a serious interest in the subject. The author, in executing this work, kept very close to the original proposal and has treated this subject comprehensively, but has at the same time presented the mathematical and physical concepts in a simple and straightforward manner.

The first section describes the physical nature of the atmosphere, the nature of various pollutants and the way in which they are introduced into the atmosphere.

In sections 2 and 3, the meteorological factors affecting pollution conditions such as wind, turbulence and stability are described.

In section 4, the concepts of dispersion from a single source are introduced. The application of the Gaussian distribution to pollution concentration in a spreading plume is explained, and techniques are described for estimating the horizontal and vertical spread.

Section 5 deals with the same concepts, considering multiple sources.

In section 6, the large-scale meteorological factors are discussed (air-mass type, anticyclone inversions, etc.) and their effect on pollution situations.

The last section presents a discussion of forecasting techniques which can be used to give warning of high pollution conditions and the use of climatology in planning new industrial and urban development.

The appendix includes numerical tables based on the formulae and concepts introduced in section 4 - The distribution of pollutant from a single continuous source. Examples are given in the use of these tables to solve specific problems.

In addition to bibliographic references, the author also provides a list of further reading for those who wish to pursue the subject in greater detail.
Source: 5

#1948
Foster, N.W. and I.K. Morrison. "Distribution and cycling of nutrients in a natural Pinus banksiana ecosystem." Ecology, 57:110-120 (1976).

Data on dry matter and N, P, K, Ca, and Mg contents and movements in soil and ground vegetation in a 30 year old natural Pinus banksiana Lamb. stand in northern Ontario are presented, together with previously published aboveground data. Dry matter and N, P, K, Ca, and Mg contents of trees were 90.700; 165; 14; 82; 112; and 18 kg/ha, respectively - less than in many Pinus spp. of comparable age in other parts of the world. A comparison with nutrient contents in younger (20 year) and older (65 year) stands on the same site indicated that most nutrient accumulation in vegetation takes place in the first decades of stand development. Annual nutrient uptake by all vegetation was 32 kg N, 2 kg P, 18 kg K, 21 kg Ca, and 3 kg Mg per hectare. Between 71% and 89% of the elements taken up annually by trees were returned to the soil by litterfall and leaf wash. There was a buildup of forest floor organic matter with stand age and N, P, and Mg accumulated in this material faster than the other elements. Soil reserves of plant-available or mineralize nutrients were maintained by nutrient replenishment from precipitation and vegetation-soil nutrient cycling. Thus, we conclude that removal of elements from the ecosystem by logging or burning should not result in significant impoverishment of this site.
Source: 5

#1296

Fourcy, A., and M. Neuburger. "Contribution de l analyse par activation a l etude fine de la composition minerale des matieres vegetales. Applications a la physiologie des elements traces, au controle des traitements, aux pollution et a la radio-ecology." (Study of the inorganic components of plants by radioactivation analysis. Application to the physiology of trace elements to treatment control, to pollution, and to radio-ecology). Text in French. Bull. Soc. Chemi, France, 11:4681-4686 (1968).

The principle of radioactivation analysis is described, and the possible application of this method to the detection and determination of trace elements in plant materials, including foods and industrial raw materials of vegetable origin, are surveyed. Radioactivation analysis, characterized by high sensitivity and selectivity, is possible either without chemical separation or by separation on ion exchange resins, electrolysis, or selective distillation. Radioactivation analysis is suitable for the detection in plant materials of such elements as manganese, copper, iron, cobalt, zinc, magensium, molybdenum, tungsten, cesium, scandium, sodium, potassium, arsenic, bromine, calcium, barium, rubidium, strontium, lanthanum, as well as fluorine and chlorine, the latter two being present in plant materials as a result of uptake from air.
Source: 1

#1297

Fowler, D., and M. H. Unsworth. "Dry deposition of sulphur dioxide on wheat." Nature (London), 249(5455):389-390 (May 24 1974).

An extensive series of measurements of dry deposition rates of sulfur dioxide in a field of winter wheat were measured and factors which may limit the deposition rate are discussed. Measurements were made over 1- or 2-hour intervals during the period from June 8 until August 12, 1973. The annual SO_2 deposition was about 47 Kg/ha. Surface wetness had a major influence on dry deposition rates. The surface resistance is the controlling step in deposition to vegetated surfaces. The dry deposition rates of SO_2 may be considerably enhanced in the winter when surfaces are wet for long periods.
Source: 1

#184

Franke, W. "Ueber die Beziehungen der Ektodesmen zur Stoffaufnabme durch Blaetter. III. Mitteilung, Nachweis der Beteiligung der Ektodesmen an der Stoffaufnahme durch Blaetter mittels Radioaktiver Stoffe." (Pertaining to the relationship of the ectodesmata to the uptake of nourishment through the leaves. III. Report. Proof of the participation of the ectodesmata on the uptake of nourishment through the leaves by means of radioactive substances). Translated from German. Belov and Associates, Denver, Colo., 20 p., Feb. 10, 1970. Planta, 61:1-16 (1964).

The role of ectodesmata in the uptake of nourishment through leaves was investigated by means of a radioactive tracer. When droplets of radioactive solutions were applied to the cuticle of Spinacio oleraces and Viola tricolor, micro-autoradiograms showed that the guard cells and anticlinal walls of the epidermis are the favored sites of absorption. Scattered black spots in the stripping film were also observed above the periclinal walls of the epidermis. Comparison of the micro-autoradiograms with the distribution of the ectodesmata in the leaf epidermis showed that the areas of absorption correspond to the areas of the densest accumulation of ectodesmata; the ectodesmata in the less absorbing preclinal walls are more loosely dispersed. This agreement is considered as proof that the ectodesmata serve as transport tracks for the intake of substances through leaves. These experiments confirm earlier statements that guard cells participate in foliar absorption. The micro-autoradiograms also show that absorption does not occur through the pores of the guard cells.
Source: 1

#185
Freebairn, Hugh T. "Reversal of inhibitory effects of ozone on oxygen uptake of mitochondria." Science, 126(3268):303-304 (Aug 16, 1957).

The effects of ozone on mitochondria were studied. Ozone, produced by passing oxygen through a high-voltage discharge tube, was diluted with filtered air through rotameters to give the desired concentration. Mitochondrial preparations were obtained from cabbage, spinach, and liver. Results indicated that when reduced glutathione and ascorbic acid were added together to the ozone-treated mitochondrial suspensions, an apparent reversal of the ozone inhibition took place. Partial reversal of the ozone inhibition was obtained when the two compounds were added separately. When 15 micromoles of hydrogen peroxide were added to an untreated cabbage mitochondrial preparation, there was an immediate evolution of oxygen which continued for some time. It took 76 micromoles of hydrogen peroxide to cause a 30% inhibition in rate of oxygen uptake. The 30% inhibition was reversed with 16 micromoles of ascorbic acid and 20 micromoles of reduced glutathione. The addition of excess co-factors (sodium ethylene-bis(dithiocarbamate); sodium bisulfide; cysteine; and 2,3-dimercapto-1-propanol) to ozone treated mitochondria did not reverse the ozone inhibition. It was concluded that the effects of small amounts of ozone on mitochondria were reversed by ascorbic acid, reduced glutathione, and ozone-affected enzymes that were associated with the mitochondrial citric-acid-cycle activity.
Source: 1

#186
Freebairn, H. T. "The prevention of air pollution damage to plants by the use of vitamin C sprays." (Presented at the 52nd Annual Meeting, Air Pollution Control Assoc., Los Angeles, California, June 21-26, 1959). J. Air Pollution Control Assoc., 10(4):314-317 (August 1960).

The amount of protection which vitamin C provided for plants against ozone and smog was investigated. In the laboratory, plants were treated with ascorbate salt by addition to the solution surrounding the roots of plants

growing in water culture. The plants were then fumigated with 7-10 ppm of ozone for 2 hours. Poa annua plants growing in a greenhouse were sprayed with 0.04M potassium ascorbate for varying numbers of days before being exposed to polluted air. Similar methods were used on other plants and flowers grown under glass. Lettuce and spinach plants growing commercially were sprayed in the field for one, two and five days per week with potassium ascorbate. Smog attacks occurred about 20 days after spraying was initiated. In these field tests no significant amount of protection was obtained for the spinach; however, a 66% protection was obtained for the lettuce with a 2 day/week application and an 82% protection with a 5 day/week appllcation. The results of the lab and field tests indicated that vitamin C moved into the leaf cells of some plants and thereby increased the tolerance of the cells to the damaging agents in smog. The protection afforded by vitamin C in the lab from ozone and in the field from air pollutants implied that either ozone was a damaging agent in the field or that vitamin C was effective against other toxic agents in the field.
Source: 1

#367
French, R. C., and R. L. Weintraub. "Pelargonaldchyde as an endogenous germination stimulator of wheat rust spores." Arch. Biochem. Biophys. 72:235-37 (1975).

Pelargonaldehyde stimulated germination as well as in vitro formation of appressoria, vesicles, and other structures produced normally during the course of infection of the wheat plant by wheat rust. The chemical is a common constituent of the oils of ginger, rose, cinnamon, lemongrass, arris root, mandarin, lime, lemon, and orange, in the turpentine from certain species of pine and is formed on rancidification of soybeans, peanut oil, and meat.
Source: 7

#1108
Frenkiel, F. N. "Atmospheric pollution and zoning in an urban area." Sci. Mon. 82(4):194-203 (1956).

Atmospheric pollution has five stages which are production of the pollutants, emission transfer, contact of the pollutants with people, animals, and plants, and then, damage to health and property. While developing an urban area, "air zoning," meaning the amount of atmospheric pollution tolerable in the area, should be considered. There are diagrams and discussion of traffic volumes and emissions from cars, industries and incinerators in the Los Angeles area. The author discusses temporary emergency measures and reduction of pollution from existing sources.
Source: 8

#1298
Frey, John E. "The effects of ozone on the synthesis and storage of nutrients in soybean seeds." Northern Colorado Univ., Greeley Biology Dept., Thesis (D.A.), Ann Arbor, Mich., Univ. Microfilms, Inc., 110 p. (1972).

Soybean plants were subjected to daily ozone fumigations of 25, 50, and 75 pphm throughout their life cycles to determine the effect of 03 on the vegetative biomass, seed yield, and lipid, phosholipid, fatty acid, crude fiber, amino acid, and protein contents of the seeds. The vegetative biomass of the plants grown in a 75 pphm 03 environment was reduced 53.8% as compared to that of the control. Fumigation with 50 pphm reduced the biomass by 22.3%. The reduction in seed yield in the 75 and 50 pphm 03 environments was 77.8 and 54.6%, respectively. The seeds produced in the 75 pphm 03 environment showed a 5.18% decrease in lipids and a 40.1% increase in free amino acids. In the 50 pphm 03 environment, the lipid decrease was 3.78% and the amino acid increase was 20.6%. Ozone fumigation had no effect on the protein and crude fiber contents of the seeds.
Source: 1

#1167
Fried, M. "The absorption of sulfur dioxide by plants as shown by use of radioactive sulfur." Soil Sci. Soc. Amer. Proc., 13:135-138 (1948).

By the use of radioactive sulfur as a tracer, it was demonstrated that alfalfa plants can take in sulfur dioxide through the leaves and convert it into organic sulfur compounds. Therefore, sulfur dioxide of the atmosphere is a source of sulfur in the nutrition of the plant.

Radioautographs of alfalfa plants containing radioactive sulfur taken up from the nutrient solution showed that when alfalfa is grown at low levels of sulfur fertility, the amount of sulfur in the veins is definitely lower than the amount of sulfur in the intravenous tissue. The radioautographs also showed a higher concentration of sulfur in the younger tissues.
Source: 5, 6

#982
Friend, J. P., R. Leifer, and M. Trichon. "On the formation of stratosphere aerosols." J. Atmos. Sci., 30:465-479 (1973).

Laboratory observations were made of the formation of Aitken nuclei and large particles in systems of air containing trace quantities of H_2O, SO_2, NH_3, and O_3, in varying conditions of radiation with ultraviolet light. These studies yielded information concerning the photooxidation of SO_2, the mechanism of formation of stratospheric aerosols, and the possible role of trace organic gases in atmospheric nucleation processes. Specific results were:

1. The quantum yield for the homogeneous oxidation of SO_2 with irradiation in the first excited band is less than 1.0×10^{-9}.

2. The addition compounds of NH_3 and SO_2, if they form, are not precursors to the formation of ammonim sulfate in the atmosphere.

3. Aitken nuclei are formed by oxidation of SO2 by O atoms with traces of water vapor present.

4. The addition of NH_3 to the system of SO_2 with O atoms gives very rapid production of high concentrations of Aitken nuclei and large particles, probably of ammonium sulfate.

5. Irradiation of air with H_2O vapor and trace organic gases at wavelengths of 2500 Å produces Aitken nuclei.

The proposed chemical mechanism for the formation of stratosphere aerosols based on the laboratory experiments is:

$$O_3 + h\nu (\lambda\ 2000\text{-}3000, 4500\text{-}6500\ \text{Å}) \rightarrow O_2 + O$$

$$SO_2 + O + M \rightarrow SO_3 + M$$

$$SO_3 + H_2O \rightarrow H_2SO_4$$

$$H_2SO_4 + H_2O \rightarrow H_2SO_4 \cdot H_2O$$

which after n - 1 steps becomes

$$H_2SO_4 \ (n-1)H_2O + H_2O \rightarrow H_2SO_4 \cdot nH_2O.$$

Reactions (4a)-(4n) produce sulfuric acid embryonic nuclei:

$$NH_3 + H_2SO_4 \cdot nH_2O \rightarrow NH_4 + HSO_4 - nH_2O.$$

$$NH_3 + NH_4 + HSO_4 - NH_2O \rightarrow 2NH_4 + SO_4 - nH_2O.$$

while reactions (5) and (6) produce salt embryos:

$$2SO_2 + H_2O + O_2 \xrightarrow[NH_4+]{\text{salt embryos}} 2H_2SO_4 \ \text{(solution)}$$

Reaction (7) is rapid oxidation of SO_2 in solution. Continued addition of NH_3 neutralizes the acid providing more NH_4+ catalyst.

The mechanism explains many of the observed characteristics of stratospheric aerosols. Hypothetical considerations show how large volcanic injections of SO_2 into the stratosphere can produce a long-lived H_2SO_4 aerosol which eventually becomes neutralized as NH_3 from the troposphere mixes into the stratosphere.
Source: 8

#1942
Frizzola, J.A. and J.H. Baler. "Contaminants in rainwater and their relation to water quality." Water and Sewage Works, pp. 95-96 (Sept. 1975).

Data collected to study the effect of rainwater quality on groundwater in Long Island, has yielded information on the major ion concentrations in precipitation. Analysis of the data, collected in recent years, indicates that scientists, engineers and public officials can no longer consider rainfall as the pure dilution elixir for groundwater.
Source: 5

#1955
Froriep. S. "Die Bedeutung der Gruenflaechen im Immissionsbelastenten Ruhrgebeit und Folgerungen fuer die Landesplanung." (The importance of open (green) spaces in the polluted Ruhr and the resultant consequences for land-use planning in the Ruhr). Presented at the International Symposium of Forest Fume Damage Experts, 7th, Essen, West Germany. Mitt. Forst. Bundesvers., 97: 107-116 (1972).

The Siedlungsverband Ruhrkohlenbezirk (SVR) is the fourth largest urban area in the world, covering an area of 4600 sq km, with a population of 5.5 million people. Apart from its legal obligations in the field of land-use planning, the SVR undertakes other important tasks in the field of landscape care and conservation. Included in the latter are open (green) spaces, which help to improve the climate in the development area, reduce temperature extremes, restore the air, and provide recreational space. Despite the fact that open spaces in urban areas are in danger of being put to other civic or industrial uses, only about 10,000 ha of the SVR's forest area have been lost; the present forest forms 15.5% of the total surface area of the SVR region. Efforts should be made to increase this percentage via the use of marginal land, waste land, tips, spoil mounds, and other unused areas. The regional development plan, drawn up by the parliament of the SVR in 1966 and ratified by the Province of North Rhine-Westphalia, is the basic prerequisite for the conservation and shaping of the landscape. Also, the natural landscape is treated as an important prerequisite for recreation outside the central areas. However, a further reduction in the pollution which adversely affects the vegetation is a prerequisite for the conservation of the natural basis of life for man. Environmental hygiene must therefore be included in environmental planning.
Source: 1

#1300
Fujita, N., and A. Kawamoto. "Tokyo tonai toritsu koen nadono jumoku no sei shogai ni tsuite." (On the growth disturbance of trees in Tokyo metropolitan public parks) . Text in Japanese. In: Studies on Tokyo Smog. Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 542-555 (March 1974).

The results of monthly surveys on the degree of growth disturbance of trees in several parts of Tokyo since 1971 are reported. The survey consisted of investigation early abnormal leaf-fall and discoloration of leaf presented

in percentage according to the species and park. The period of survey was from May 1973 to April 1974, and the species of trees were zelkova, weeping willow, Carolina poplar, Osmanthus fragrans var. aurantiacus and camphor. The growth disturbance of zelkova was more serious in the central parts of the metropolis than in the suburbs until 1971. In 1972, a leaf-fall of zelkova did not appear and discoloration of leaf was slight until September. In 1973, the early leaf-fall was a little greater than in 1972, especially in July, however, the amount of leaf-fall was very small until autumn and discoloration of leaf was the same as in 1972. It was commonly recognized that Osmanthus fragans var. aurantiacus did not flower in the metropolitan central areas, however, in 1972 about 70-80% of the trees flowered and in 1973 all the old trees flowered fully. Until 1970 chlorosis was seen in ginko leaves. Since 1971, however, the chlorosis has decreased, and in 1973 no necrosis was found until autumn. The recovery of plant vigor could not yet be related to climate and degree of air pollution.
Source: 1

#24

Fujiwara, T. "Sulfur accumulation form and development of injury symptom in plants which absorbed SO_2." Amn. Phytopath. Soc. (Japan), 36; 127-131 (1970).

Author examined sulfur accumulation found in plants which absorbed S by contact with a low SO_2 concentration. He also conducted experiments on absorption from soil and atmosphere. Levels of S content in soil of test plants were changed by applying nutrient solutions containing 0, 12, 60, or 120 ppm $Na_2 SO_4$ four times over a one month period. Gas exposure also used. Author correlates contact period with injury development. Inorganic S content became large but S content of soluble organic S and protein S was almost no different in either the control region or the gas contact region.
Source: 8

#1301

Fujiwara, Takashi. "Taiki no fukugo oxen ni yoru shokubutsu no higai." (Damage to plants by complex pollution of the atmosphere). Shokubutsu Boeki (Plant Prot.), 27(6):233-236 (June 1973).

Plant damage caused by secondary pollutants such as peroxyacetyl nitrate or ozone are discussed. Several pollutants can cause a different effect on plants than an individual pollutant acting alone, those include sulfur dioxide plus ozone, SO_2 plus nitrogen dioxide, NO_2 plus O_3, and SO_2 and NO_2 plus O_3, PAN or SO_2 plus fluorides, O_3 plus fluorides, and hydrocarbons plus SO_2, NO2 or O_3. There are additive, more than additive, or less than additive effects of coexistance. The specific effects of the synergistic action of two or more pollutants include necrosis and discoloration. In the case of SO_2 acting in conjunction with O_3, the lowest concentrations causing damage are 0.12/0, 0.1/0.01, and 0.05/0.05 ppm/ppm on green peas; no damage appeared at 0.1/less than 0.2; slight damage occured at 0.2/0.1-0.2 ppm/ppm; and the addition of more O_3 gave no more damage. The effect of SO_2 and O_3 on radishes was additive or less than additive; the effect of SO_2 and O_3 on Satsuma oranges was additive.
Source: 1

#1304
Fujiwara, Takashi and Haruhiko Ishikawa. "Chisso sankabutsu no ni, san shokubutsu ni oyobosu eikyo." (The effects of nitrogen oxides on various plants). Proc. Symp. Japan Soc. Air Pollut., 13th, p. 234. (Nov. 7-9, 1972).

The effects of nitric oxide and nitrogen dioxide on plants and vegetables were observed by the use of vinyl exposure chambers. The concentration in the chamber was constantly checked by a detector and the Saltzman method, or by an automatic electrochemical meter. Rice, soy bean, sweet potato, sesame, tomato, eggplant, cucumber, strawberry and grape plants were exposed to 4-10 ppm NO2 for 4-8 hr. Soybean and buckwheat plants showed a waxy appearance on the leaves when the exposure was completed, and then gradually chlorosis appeared. Grape leaves showed a black mottling the day after the exposure. When the gas concentration was increased to 20 ppm, these symptoms appeared on most of the plants. Eleven kinds of vegetables and plants were exposed to 0.3-0.6 ppm SO2 for 13-55 days. Tomatoes, eggplants, and buckwheat leaves dropped, and the growth was impaired on buckwheat, eggplants, and radishes.
Source: 1

#1305
Fukuda, H. and K. Terakado. "Kokagaku sumoggu ni yoru asagao higai no tokucho." (Specific features of the damage of morning glory due to photochemical smog). In: Tokyo Nogyo Shikenjo Sokuho, 33-34 (Feb 1974).

Although the phenomenon of damage of morning glory due to photochemical smog has been known, no fundamental investigations have been carried out concerning the relationships between the concentration of the photochemical smog, the onset, and degree of thedamage; those between leaf age and damage; and the physiological and the metabolic change due to exposure to photochemical smog. The relationship between the damage index and the concentration and duration of the photochemical smog was investigated in order to test the morning glory as a plant indicator. The plant was exposed to the pollutant in the lab from Aug. 16 to Sept. 21, 1973. The results of nine experiments were: toxic threshold value was 8 pphm for 3 hr of exposure; the necrotic threshold values were 8 pphm for 9 hr, 9 pphm for 6 hr and 10 pphm for 5 hr of exposure. When the injured leaf area was directly used as the index of damage (except necrosis), the highest correlation was to the cumulative concentration. Plant growth was affected, and the age of the leaves showed different levels of suceptibility. Morning glory is appropriate for use as a plant indicator, but species specific toxic tolerances must be taken into account.
Source: 1

#1299
Fujii, S. "Okayama-ken ni okeru taiki osen ni yoru shokubutsu higai no genjo." (The status quo of plant damage by air pollution in Okayama prefecture). Text in Japanese. Shokubutsu Boeki (Plant Prot.), 27(6):249-252 (1973).

Plant damage in Okayama Prefecture includes grape damage caused by fluorine from a firebrick manufacturing factory and vegetable and fruit tree damage due to oxidants such as ozone. By regulating hydrogen fluoride concentrations to less than 5 ppb/hr, grape damage was eliminated. Ozone damage (withering) has occurred on taro, Japanese leek, and Japanese radish. Experimental exposure of plants to 0.4-0.5 ppm for 1.5-6.0 hr., 0.25-0.3 ppm for 4-7 hr., and 0.25 ppm of O_3 p us 0.1 ppm of sulfur dioxide for 2-2.5 hr caused deep green spots on taro, which developed into white or grey spots on the leaves. Japanese leeks had whitening of leaf tops when exposed to 0.5 ppm of O_3 for 2 hr., 0.25-0.3 ppm for 5-6 hr., 0.1 ppm for 14 hr. and 0.25 ppm of O_3 plus 0.1 ppm of SO_2 for 4.5 hr. Recently other plants have suffered damage such as insufficient growth, lack of fruit, defoliation, and dropping of fruit, which suggest damage due to e hylene. Sulfur dioxide is suspected of causing tip-withering of mat grass in the southern part of Okayama Prefecture.
Source: 1

#1303
Fujiwara, Takashi. "Chisso sankabutsu no shokubutsu ni oyobosu eikyo ni tsuite." (Effects of nitrogen oxides in the atmosphere on vegetation). Kogai to Taisaku (J. Pollution Control), 9(3):253-257 (March 1973).

Rice plants, soybeans, sweet potatoes, sesames, tomatoes, eggplants, green peppers, cucumbers, strawberries, and grapes were exposed to nitric oxide (20 ppm) for 7 hr in the presence of 0.7sl.3 ppm nitrogen dioxide, but did not show any sign of damage. However, when NO is oxidized and becomes NO2, drastic damages occur on the plants. With NO2 of more than 2-3 ppm concentration. plants receive damage similar to that from sulfides, spots in the initial stage, and gradual chlorosis. If the pollutant is eliminated after the initial spotting, the damage will disappear. The degree of damage depends on the specimen. When various plants are exposed to 4-10 ppm NO2 for 4-8 hr, some damages are noted on soybeans and buckwheat in 4 hr at 4 ppm; the same damage occurs on grapes in 7 hr at 10 ppm. Most plants show damages in 30-60 min when exposed to 20-50 ppm. When exposed to low concentrations of NO2 over a long period, tomatoes, eggplants, and buckwheat react to 0.6 ppm. The growth is hindered on buckwheat, eggplants, and radish. However, the rice plant increases the growth rate. Chlorophyll increases drastically in pinto bean leaves when they are exposed to 0.33 ppm NO for 10-19 days. When 12-15 ppm NO2 coexists with 1.5-2.4 ppm of sulfur dioxide, the damages to string beans, tomatoes, cucumbers, and pepper multiply. The experiment on green pea exposure to 0.1 ppm SO2 and 0.2 ppm NO2 did not show the multiplication effect. However, an exposure to 0.1 ppm SO2 and 0.1 ppm ozone showed a marked multiplied damage.
Source: 1

#1306
Fukuda, H. and K. Terakado. "PAN ni yoru shokubutsu higai ni tsuite." (On the damage of plants due to peroxyacyl nitrates (PAN)). In: Tokyo Nogyo Shikenjo Sokuho, 35-36 (Feb 1974).

Peroxyacyl nitrates (RCOOONO2) formed by the photochemical reaction between hydrocarbons and nitrogen oxides in polluted air give specific damages such as silvering and bronzing to plants at a very low concentration. In Japan the plant damages began to resemble those due to PAN from about 1972. Exposure experiments with artifically synthesized PAN in an environment simulation room determined the concentration of PAN and its duration to examine the relationship between these data in fields and the crop damage. Synthesized PAN created by irradiating a mixture of ethyl nitrate and oxygen with ultraviolet light gave results similar to those seen in fields. From the end of April to the end of November, damages to petunias seemingly due to PAN appeared 15 times. The symptoms differed by the variety of petunia. After 14 experiments in fields from Sept. 20 to Nov. 30 with a continuous determination of the environmental concentration of PAN, damages to petunia were confirmed on 6 days when the maximum PAN concentration range was 3.0-5.7 ppb. The duration of concentrations higher than 3 ppb was 2-13 hr. The most serious damage appeared on Sept. 20 when a concentration of more than 5 ppb continued for 7 hr. No damage appeared with a long continuation (6-12) hr. of a lower concentration of PAN of 2 ppb. Inter-varietal grafting showed that the symptoms and the degree of damage due to PAN were influenced only by the physiological specificity of aerial portion of the plant. Leaves which are most affected by PAN differed with the variety of petunia.
Source: 1

#1852
Fukuoka. Y. "Azuma sukai rain ni okeru taiki osen to shokubutsu higai." [Air pollution and plant damages along the Azuma skyline]. Japan Soc. of Air Pollution, Proc. Symp., 13th, p. 233 (Nov. 7-9, 1972).

The effects of air pollution on the plants alongside the Azuma Skyline Drive in Fukushima Prefecture were investigated between Aug. and Oct. 1971. Carbon monoxide, nitrogen dioxide, sulfur dioxide, humidity, temperature, wind direction and speed, plant conditions, and the traffic conditions were investigated. The pollution and plant damage trends were classified according to the topography. In the middle of the slopes, a high concentration of CO (8-20 ppm) was generally found, and plant damage was heavy on the valley side. At the bottom of valleys, pollution was normal (CO, 7 ppm), and the tree damage was heavy in the lee. On the top of hills, the concentration depended on the weather conditions, especially on fog and wind velocity; much damage was noted on both sides of the road. Where the road was lined by trees on both sides, the concentration tended to be slightly high (7-12 ppm of CO), and the plant damage was prevalent in the lee. On curved roads, pollution was not high; both in the lee and on the valley side, some dead trees were noted. Parking areas were generally well ventilated and the concentration was rather low (CO 0-4 ppm) for the number of cars.
Source: 1

#1302
Fujiwara, T., and H. Ishikawa. "Taiku-chu no SO_2 ga sosai-rui no gaicho hatsugen to seiku ni oyobosu eikyo." (Effects of atmospheric sulfur dioxide on the incidence of injury symptoms in vegetable crops and on their growth). Translated from Japanese. Leo Kanner Assoc., Redwood City, Calif., 16 p., December 1972. Noden Kenkyusho shoho (Agr. Lab. Cent. Res. Inst. Elec. Power Ind.), 11:87-96 (May 1971).

The effects of atmospheric sulfur dioxide on the incidence of injury symptoms in vegetable crops and on their growth were investigated. Four types of fruit crops (tomato, eggplant, cucumber, and green pepper), two types of root crops (turnip and radish), and four types of leaf crops (Chinese cabbage, cabbage, lettuce and spinach) were continuously exposed for periods of 14-56 days to gas with a concentration of 0-0.26 ppm of sulfur dioxide. Observed injury symptoms included: grayish-white or brown flecks on the leaves, yellowing of the leaves, and morphological changes in the leaves. The green peppers and the radishes had the greatest resistance to SO_2 of all the vegetables tested; no injury symptoms appeared at 0.26 ppm; and there was no inhibition of their growth. The spinach was the most sensitive, with injury symptoms appearing on the first day. Other crops displayed a medium degree of sensitivity. Inhibition of growth was observed only in turnips, Chinese cabbage, and cabbage. There was no direct effects on flowering and fruiting within the experimental range of gas concentrations.
Source: 1

#782

Fujiwara, T., T. Umezawa, and H. Ishikawa. "Taiki osen fukugo no shokubutsu ni oyobosu eikyo ni kansuru kenkyu. 1: SO_2, NO_2, O_3 fukugo no eikyo." (Effects of mixed air pollutants on vegetation. Part I. Sulfur dioxide, nitrogen dioxide and ozone to injure peas and spinach). Text in Japanese. Noden Inst. (Japan), Central Institute of Electric Power, Rept. 72007, 12 p. (August 1973).

Effects of sulfur dioxide, nitrogen dioxide, and ozone, singly and combined on foliar injury to potted garden peas and spinach were studied in a controlled condition room under artificial illumination. After exposure for 4 hr. and kept until the next day, the degree of the injury was the highest with a mixture of three pollutants, followed by that of O_3 and SO_2, then by that of O_3 and NO_2, and then by O_3 only. The respective concentrations of the three gases were 0.10-0.11, 0.20-0.21, and 0.10-0.11 ppm in the above order.
Source: 1

#1307
Fukushima, K. "Cadmium in various food products." (Japan). Proc. Sci. Res. Meet. Itai-Itai Dis. Cadmium Poisoning, Tokyo, Japan (Aug. 28-29, 1971).

The cadmium concentrations in 340 samples of food products marketed in Kanzawa City, Japan are reported in terms of net sample weight, per 2400 calor-

ies, and per 70 grams of protein. The results indicate that mollusks, internal organs, and colored vegetables contain considerably more Cd than does rice, that processed food tend to contain more Cd than unprocessed foods and that ocean fish contain more Cd than river fish. The estimated daily Cd intake per person is a little less than 50 micrograms, calculated on the basis of the average Cd concentrations in the food products; this figure is compared to similar figures for persons in the United States and Germany. The average Cd intake of a farm worker in an itai-itai region is estimated to be over 700 to 800 micrograms.
Source: 1

#1168
Furrer, O.J. "The amount of SO2 absorbed by plants from the atmosphere." In: Isotopes in Plant Nutrition & Physiology, 403-407 (1967).

To measure the uptake of atmospheric sulphur, the plants were cultivated in nutrient solutions containing radioactive sulphate (35S). The nutrient solutions were bubbled by sulphur-free air and hermetically separated from the surrounding atmosphere containing inactive SO2. The experiments were carried out with different species of plants, with varying amounts of sulphate in the nutrient solution and with varying amounts of sulphur dioxide in the atmosphere. The amount of sulphur and the specific activity of 35S were determined in the organic and inorganic inaction of the different parts of the plants. The absorption of atmospheric sulphur by plants was greater with higher concentrations of sulphur dioxide in the air. On the other hand, the uptake of atmospheric sulphur by plants was lower with higher sulphur concentrations of the nutrient solution. Sulphur from the atmosphere was found in greater concentration in the inorganic than in the organic sulphur fraction of the plants. Sulphur from the atmosphere was also found in the roots but in lower concentration than in the tops of the plants. The radioautographs showed a higher concentration of sulphur in the younger tissues.
Source: 6

#1582
Furukawa, A. and M. Kadota. "Effect of ozone on photosynthesis and respiration in poplar leaves." Environ. Control Biol., 13(1):1-7 (March 1975).

Experiments were carried out to determine the effect of ozone fumigation on the rate of carbon dioxide (CO2) exchange of detached poplar leaves in the light (24 klux) and in the dark. The detached poplar leaf was placed in an assimilation chamber, and the CO2 concentration of the air at the inlet and outlet was measured by an infrared CO2 analyzer. The rate of CO2 exchange was determined before and after exposure to 0.9 ppm ozone at 25 C at an air flow rate of 1.5 l/min. Both net photosynthesis and CO2 evolution in the light were considerably decreased. However, dark respiration was increased after the ozone fumigation. The light and CO2 compensation points were significantly higher in the ozonated leaves.
Source: 1

#187
Gableman, W. H. "Alleviating the effects of pollution by modifying the plant." Hort. Science, 5(4):250-252 (August 1970).

The thesis that genetic change and recombination provide a vehicle for permanent change by which plants may either exclude a pollutant from entering the plant or provide physiological systems which allow the plant to tolerate excesses of toxic pollutants is discussed. Both mechanisms are known to exist among plants adapted to low pH soils where manganese toxicity eliminates many species. The cranberry plant thrives in a soil pH of 4.0-4.5 and a tissue content of 3000-4000 ppm manganese. There are a variety of mechanisms involved in the accumulation of levels of soil pollutant minerals in the plant which are toxic to the ultimate consumer, and the magnitudes of differential absorption through the roots among various species is greater than generally realized. Two avenues through which air pollutants enter the leaf are generally recognized: by direct penetration of the cuticle and by diffusion through open stomata. The apparent differences in resistance and susceptibility to ozone injury by different species are generally accepted. The apparent heritability of resistance and susceptibility within a species is becoming more obvious. If responses to ozone can be detected in leaf discs, the technique can be modified to survey vast amounts of plant material quickly.
Source: 1

#1476
Galbally, I. E. "Production of carbon monoxide in rain water." J. GeoPhys. Res., 77(36):7129-7132 (Dec. 20 1972).

The carbon monoxide supersaturation of rain water was studied, and a dynamic model was constructed to predict the observed daytime supersaturation levels. The hypothesis of CO production was based on the photolysis of formaldehyde and higher aldehydes by ultraviolet light (sunlight). The model dynamics and postulations are reviewed. The relevance of the hypothesis to CO supersaturation to ocean surface waters was also considered, since the ocean surface water appears to be a major source of CO in the global cycle.
Source: 1

#456
Ganje, T.J. and A.L. Page. "Lead concentrations of plants, soil and air near highways." Calif. Agr., 26(4):7-9 (April 1972).

Lead found in and on crops in highway proximity tests in Southern California was caused principally by aerial deposition. Substantial amounts of lead were removed from exposed plant tissues by distilled water washing. Amounts of lead in and on crops were influenced by distance from the highway, extent of plant surface exposed, external plant characteristics, duration of plant exposure, motor vehicle traffic density, and direction of prevailing winds. In soils and suspended air particulates, lead concentration was influenced by distance from highways and the direction of prevailing winds. Crops surveyed included lima bean, corn, sugar beet, tomato, wheat, alfalfa, and oranges.
Source: 1

#1310
Garber, K. "Erfahrungen mit der Blattanalyse bei Rauchschadenuntersuchungen." [Experience with leaf analysis in smoke damage tests]. Angew. Botan., 34:33-37 (1960).

The role of chemical analysis in examining plant material for damage caused by smoke is discussed. Most difficult is the diagnosis of SO2 damage, even in case of leaf discoloration, because this symptom is not specific. An increased content of sulfur in leaves can be an indication of damage by SO2 but this proof is not reliable, since plants can manifest elevated sulfur levels through intake from the soil. A quantitative micromethod for the detection of SO2 in fresh leaves has been developed by G. Bredemann and H. Radeloff. Hydrochloric acid and chlorine can also be detected by a micromethod (Ag-NO3) but it is no proof of damage because the natural chloride content in plants fluctuates widely. The same holds for NO2 and NO3. Ammonia can be detected microchemically with great reliability; fluorine can also be detected microchemically and positive tests usually indicate the cause of damage, but the fluorine test is not always reliable. A sensitive and reliable microchemical test also exists for asphalt and tar vapors. Thus, if the circumstances of the damage and local conditions are known, microchemical leaf analysis is useful as an auxiliary method in attributing damage to a specific agent. But leaf analysis by itself does not constitute conclusive proof.
Source: 1

#188

Garber, K. "On the absorption of harmful substances through tree bark." Wiss. Z Tech. Univ. Dresden. Translated from German. Vol. 3 10 p. (November 14, 1961).

The absorption of fluorine, fluoride compounds, tar, asphalt vapors and ammonia through the bark of trees and bushes is reported. Absorption of these substances through bark during the dormant winter season was demonstrated in simulated laboratory experiments. Examination of field specimens obtained in the vicinity of a superphosphate plant indicated that the fluoride content of the bark was inversely in agreement with the distance from the source. A similar observation was made of the woody material but to a considerably lesser degree. Exposure of trees and pruned branches to HF vapor resulted in a bark concentration dependent on the exposure time and a wood concentration reflecting the exposure intensity. Applying a 2% solution of sodium fluoride to the branches caused a 50% increase in the observed fluoride content of the wood portion. Almost all the fluoride vapor exposed trees were damaged as exhibited by delayed spring growth. The leaves of exposed trees contained 2-3 times the fluoride as the control specimens. Examination of dormant branches from the vicinity of tar and asphalt processing facilities clearly indicated the presence of these substances stored in the bark, and, depending on the kind of plant, that more or less of these substances were transferred to the wood. Rough bark appeared to enhance the pickup of the substances. The transfer of these materials to spring growth was in most cases very slight. Similarly, dormant branches were exposed to ammonia and, while N_H3 could be detected in the bark in all cases, it could not be detected in the wood in all cases. The effect of low concentrations for long periods of time was greater than that of high concentrations for short periods of time. High-concentration, short-term exposure of NH3 acted as a fertilizer, causing earlier sprouting and better leaf color. Low-concentration, long-term exposures had a detrimental effect. By late May, the ammonia content of the test specimens was the same as that of the control specimens.
Source: 1

#1858
Garber, K. "Untersuchung und Begutachtung von Rauchschaeden." (Studies and evaluation of smoke damages). Translated from German. 12 p. Jahresber, Staatinst, Angew, Bot., Hamburg, 76/78:119-127 (1961).

A summary is presented of 666 studies and evaluations conducted in the field of smoke damage to vegetables, ornamental plants, fruit and other trees, and bushes. A large number of plants are categorized based on their individual sensitivity to hydrofluoric acid and sulfur dioxide gases. Depending on their chemical composition, dusts can have damaging effects on both plants and soil fertility. The calcium oxide content in soil in the vicinity of a cement plant was studied. Plant damage is traced to chlorine containing fumes in conjunction with ammonia from a zinc extrusion plant and to sulfur containing exhaust gases from warm slag used to repair sidewalks. High amounts of molybdenum in plants can be toxic to ruminants.
Source: 1

#1312
Garber, Kurt. "Neuere Literatur ueber Rauch-, Staub- und Abgasschaeden II." (Recent studies on smoke-, dust-, and waste gas-induced damages. Part 2). Angew. Botan., 36:127-184 (1962).

The most recent studies on damages induced by smoke, dust, and waste gas are discussed. The correlation is discussed between the air pollution, the size of the city, and its climate on one hand, and the health of the population on the other hand. The health of the population in industrial regions has been studied. The danger of air pollution to animals and the damages to forest vegetation have been studied. The Air Protection International Conference was held in 1959 in London. Problems of technology, measurements, investigations, research, and setting of standards were discussed. The British Department of Scientific and Industrial Research has been preparing annual reports on research concerning air pollution. In Germany, national and international conferences were held at Tharandt, Bochum Bad Lippspringe, and Hamburg in 1961. Zieger's work on damages caused to forest had numerous followers. An international meeting of the International Association of Forest Research Institutes was held in Vienna in 1961. The damages caused to agriculture and horticulture were discussed by several researchers. Pollution measurement methods, meteorological factors, pollutants, and other related matters have been studied.
Source: 1

#331
Garber, K. "Ueber die Aufnahme von Schadstoffen durch die Rinde der Baeume." (A study of the intake of toxicants through the bark of trees). Wiss. Z. Tech. Univ, (Dresden), 11(3):549-552 (1962).

The retention of fluorine and its compounds in the bark of trees is discussed. Analysis of the barks of willows, poplars and alders stemming from the vicinity of a superphosphate plant showed considerable amounts of fluorine ; hardly any traces were found in the wood. The quantitative analysis of fluorine by perchloric acid distillation showed that a relationship exists between the fluorine content in the bark and the distance of the emission

source. Gassing experiments with hydrofluoric acid on three-year old barren trees and cut branches in the winter showed that the fluorine content rose to between 33 and 65 mg in 100 g dry substance, depending on the exposure time; 1.71 to 4.28 mg fluorine was found in the wood. In non-exposed trees, fluorine concentrations of 0.0 to 1.6 mg in the bark and 0.2 to 0.3 mg in the wood were found. A further series of gassing experiments with trees during the winter period showed that the fluorine content of the leaves was twice or three times as high as that of non-exposed trees. Maple leaves from trees whose bark was treated with a 2% sodium fluoride solution also showed an increased fluorine concentration. Trees in the vicinity of a tar and asphalt plant stored higher concentrations of tar containing substances in the bark and, to a less extent, in the wood. Barren trees in the winter were exposed to ammonia. NH_3 could be found in the bark; it was not found in the wood.
Source: 1

#189
Garber, K. "Stand und Leistung agrikulturchemischer und agrabiologischer Forschung." (State and attainment of agricultural chemical and agricultural biological research). Landwirtsch Forsch., 20:116-118 (1966).

The increased fluorine content in plants in regions of fluorine emission was investigated to ascertain whether this increase might also be due to absorption from the soil. The fluorine content in different plant types in different soils, the effect of single or split application of fluorine on the growth and F content of plants and the extent of increased F content in the soil on plants was researched. The findings proved that the F content in plants does not run parallel to the natural F content of the soil. Fine, sandy, marshy and clay soils were tested. Bush beans were the experimental plants.
Source: 1

#330
Garber, K. "Effects of fluorine. Pertaining to the fluorine content of plants (1)." (Fluor-Wirkungen). Federal Inst. of Applied Botany, Hamburg, West Germany, RR-14, p. 42-48 (1967). Also: Qualitas Plant. Mater. Vegetabiles, 15(1):29-36 (1967).

Several users of research on the fluorine content of plants in non-industrial regions have shown that the natural fluorine content may vary between 0.2 and 2.0 mg/100 g dry matter. The uptake of fluorine from the soil will continue independent of the fluorine content of the soil. From these investigations, it was concluded that fluorine contents higher than the natural values indicate the influence of fluorine emissions. The fluorine contents of various plants are presented in tabular form.
Source: 1

#1209
Garber, K. "Literatur über Wirkungen der Luftverunreinigung." In: Luftverunreinigung und ihre Wirkungen (Literature on effects of air pollution). Gebrüeder Borntraeger, Berlin-Nikolassee, West Germany, pp. 223-236 (1967).

This article is a listing of publications related to the study of effects of air pollution. Some of the titles have a very brief summary attached. The following areas are outlined: general study of air pollution, effects of air pollution on forestry, and effects of specific materials, such as SO_2, dust, chlorine, auto exhaust, etc.
Source: 6

#570
Garber, K. "Status and results of research in agricultural chemistry and biology. XVIII. Air pollution by heavy metal containing dust -- effects on plants." Landwirtsch. Forsch., 21(1):59-68 (1968).

Investigations were carried out in the vicinity of a lead factory, a zinc factory, a copper factory, and a brass factory, to determine the effect of dust emissions on the vegetation in the area. The soluble heavy metal content in the rainwater was first determined. Depending on the location and the distance from the source of emission, conifer needles contained about 2342 ppm Pb, about 4000 ppm Zn, and 500 ppm Cu; grass contained 350-1200 ppm Pb, 3000 ppm Zn, and 1500 Cu. In areas having no industry, conifer needles were found to have 9-30 ppm Pb and 50-150 ppm Zn. In soils which had accumulated high concentrations of heavy metals, inhibition of plant growth was observed.
Source: 1

#785
Garber, K. "Ueber den Fluorgehalt von Pflanzen." (The fluorine concentration of plants). Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, Contract No. CPA 22-69-30, Project No. C 2439, 10 p. (1968).

Data are presented which indicate (1) that the fluorine intact by plants is independent of the fluorine concentration of the soil, and (2) that the natural fluorine content of plants lies between 0.2 and 2.0 (maximum 3.0) mg per 100g dry substance. Any higher concentrations can be traced to F containing immissions.
Source: 1

#1308
Garber, K. "Untersuchungen uber Frage der schaedigung von Waldbestaenden in der Naehe eines Kaliwerkes." [Study of damage to forest stands in the vicinity of a potash plant]. Polska Akad. Nauk. Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 429-438 (Sept. 9-14, 1968).

The effect of emissions from a potash plant situated in the southern part of Lower Saxony on surrounding fir and beech tree stands was studied. Besides sulfur dioxide, plant emissions included 80,000 cu m/hour of drying plant flue gas containing 0.8-1 g/cu m potassium chloride. In 1964 the height of the drying plant stack was increased from 52 m to 120 m. Damage which before 1964 had reached 800 m from the plant,after 1964 spread out to a distance of up to four km. Conifer needles turned brown and leaves manifested signs of peripheral necrosis. Damaged needles had a chlorine content of 0.38% Cl while needles from unpolluted areas contained 0.14%. The Cl:K ratio in damaged needles was 1:2.6, in undamaged needles 1:4.5. Similar results were found in leaves of deciduous trees. The accumulation of Cl and K can also occur from soil effects. Fast-growing species are more susceptible to pollution damage than slow-growing varieties and contained higher Cl, K, and Na levels. Populus tremula, P. canadensis, P. alba, P. canescens, and Ulmus campestris were highly resistant to potash; other resistant species included Quercus rubra, Ulmus americanus, medium resistant Populus nigra, Acer pseudoplatanus, and Fraxinus exelsior.
Source: 1

#401
Garber, K. "Fluoride in rainwater and vegetation." Fluroide Quarterly, J. Intern. Soc. Fluroide Res., 3(1):22-26 (Jan 1970).

Fluoride levels of rainwater in industrial areas of Germany ranged from 0.28mg/1 to 14.1 mg/1, depending on the kind of industry, the distance from industrial complexes, and the extent to which coal was used. Fluoride assays of various plant species showed the same trend as those in rainwater; the fluoride content of the plants increased with increased fluroide levels of air. In a hothouse experiment, plants grown in soil from the contaminated areas exhibited fluoride levels only four times higher than those in control plants. In contrast, plants exposed to airborne fluoride near a factory showed 22 to 200-fold increases in fluoride values. Even when fluoride levels in rainwater were only 10 times higher than normal, plants cultivated near rainwater testing stations were markedly damaged by fluoride emissions, suggesting that high concentrations of fluoride compounds entered the plants during brief, short-term exposures.
Source: 1

#1311
Garber, Kurt. "Schwermetalle als Luftverunreinigung - Blei, Zink, Cadmium - Beeinflussung der Vegetation." (Heavy metals as air pollutants - lead, zinc, cadmium - Influence on the vegetation). Staub, Reinhaltung Luft 34(1):1-7 (Jan. 1974).

The effects of lead, zinc and cadmium on plants are discussed. Application of fly dust containing lead and zinc to string bean plants produced chloroses on the leaves with zinc containing dusts and additional necroses with lead containing dusts. When added to the soil lead had a growth retarding effect. The yields of potatoes and tomatoes grown in sandy soil polluted with lead and zinc were much smaller than that of clayey soil. Increasing hydrolytic acidity of the soil promotes the lead intake by the plant. Tomatoes and string beans grown in the industrial areas of Hamburg in the immediate vicinity of a heavy metal-emitting plant were harvested in much lower quantities than on a control field outside the industrially polluted area. In the vicinity of metallurgical plants the concentrations of metallic pollutants are dangerously high. Near a copper plant 1280 to 290 ppm Pb, 490 to 215 ppm Zn, and 1685 to 216 ppm Cu were measured in grass depending on the distance from the plant. In the neighborhood of a zinc plant the grass measured 1700 to 785 ppm Pb, 3030 ppm Zn (400 m distance), and 980 ppm Zn (1800 m distance). The normal concentrations of Pb, Zn and Cd in vegetables are listed. For example, for grass the normal Pb concentrations is 0.3 to 1.5 ppm (measured in Scotland) which rises in late fall to 10 ppm, in the late winter to 30 or 40 ppm and then drops again. Apart from the different toxicity of these pollutants to different kinds of plants there are side effects of heavy metals on plants such as the blocking of the intake of important nutrients.
Source: 1

#332
Garber, K., R. Guderian, and H. Stratmann. "Untersuchungen über die Aufnahme von Fluor aus dem Boden Durch Pflanzen." (Investigations of the uptake of fluorine by plants from the soil). Qualitas Plant. Mater. Vegetabiles, 14:223-236 (1967).

Experiments were conducted with different soil types to determine the fluorine uptake by plants from the soil. Identical plant species showed different fluorine contents on different soils, and there was no correlation between the F-values in the soils. Additions of sodium and calcium fluoride of 5 mg F per 100 g soil (F mg%) to the soil had no effect on the F-level of the plants. Some one-year old plants indicated necrosis and discoloration, especially at the leaf tips, and a decrease in yield which was stronger for soil with CaF_2-additions. The uptake of fluorine, necrosis, discoloration, and decreased yield were more pronounced on sandy soil than on marshy or clay soils. Equal amounts of fluoride when added in one portion had a more damaging effect on the growth of Tradescantia and tomato than when added in three partial portions. The addition of NaF to oats in one portion before seeding had no effect on the F-content, but experiments with gradual additions showed a strong increase of the F-value. Soils taken from regions with flourine emissions were used to grow beans. The increased F-level in the beans is considered as proof that fluorine emissions act directly on the plant parts above the soil, and indirectly through the soil.
Source: 1

#402

Garber, K. "Einfuehrung und ueberblick." [Introduction and survey]. VDI (Ver. Deut. Ingr.) Berlin, 164:7-10 (1971).

In 1959, a sub-commission of the Association of German Engineers (Verein Deutscher Ingenieure, VDI) was formed to take care of the preparatory work for establishing guidelines concerning effects and maximum permissable values of fluorine compounds in the air. Since available data at that time were insufficient, an extensive research program was started to reduce the various known methods of fluorine analysis to one or two recognized ones and to clarify important questions in the areas of veterinary medicine and botany. The research work carried out since then yielded many interesting data, for instance relations between fluorine content in the air and the analytically determined F-content of plants. One example of reported figures refers to grass where at average F-content in the air of 1.4 to 1.7 micrograms F/cu m air, the accumulation of F in the grass amounted to 1.5 to 16.6 milligrams/100 g dry grass substance. The results of tests made inside of chambers where plants were exposed to air mixed with hydrofluoric acid under controlled conditions for about 14 days were comparable with open-air observations. The extent of damage to the plants was not only dependent on the F-content in the air, but also on other factors such as humidity, light, temperature, and conditions of growth and nourishment of the plants. An important factor for the absorption of fluorine by plants is rainfall. Measurements made in the vicinity of a phosphate plant showed 10.0 mg F/l of rain water as yearly average in locations in the main wind direction, and in the same location, an average accumulation of 185 mg F/100 g dry plant substance. The results from a measuring station located in the opposite direction were 1.85 mg F/l of rain water and 20.5 mg F/100 g dry plant substance.
Source: 1

#1309

Garber, K. "The differential diagnosis of fluoride damage to plants." (Presented at the International Society for Fluoride Research, Annual Conference, 4th, Hague, Netherlands, Oct. 24-27, 1971.) Fluoride Quarterly J. Intern. Soc. Fluoride Res., 6(1):33-40 (January 1973).

Fluorides, sulfur dioxide, hydrochloric acid, chlorine, nitrogen dioxide, ammonia, tar fumes, and ozone are toxic to plants. Not all symptoms point to the effect of a particular pollutant. For the diagnosis of plant damage caused by air pollutants, the most important criterion is the chemical analysis of leaves in conjunction with the examination by ultraviolet light of quartz lamps and the analysis of air and rain water.
Source: 1

#332
Garber, K., R. Guderian, and H. Stratmann. "Untersuchungen ueber die Aufnahme von Fluor aus dem Boden durch Pflanzen." (Investigations of the fluorine intake by plants from the soil). Franklin Inst. Research Labs., Philadelphia, Pa., Science Info Services, Contract No. CPA 22-69-30, Project No. C2439, 20 p. (1968).

This paper deals with the fluorine intake from the soil, and in particular, answers to the following questions are sought: 1. How great is the fluorine concentration of various types of plants grown in different soils. 2. What effect has a portioned fluorine addition to the soil on the F-concentration of the plant. 3. Are there fluctuations in the fluorine concentration of the plant during its vegetation period. 4. Are there any connections between the F-concentrations of various plant organisms. All investigations were performed in vitro and are based on the experiments on sulfur dioxide effects described by von Guderian (1960). The sites of the investigations are Hamburg, Biersdorf (Sieg) and Kettwig. With the majority of the experiments, the computed fluorine concentrations were mixed with the soil prior to to sowing. To determine the F-concentrations in the experimental soils as well as in the sample plants the method by Oelschlager (1960) was used. The same types of plants show different F-concentrations which moreover do not correlate with the fluorine concentrations of the soils. The fluorine concentration of plants thus is not solely a function of the absolute fluorine concentration of the soil.
Source: 1

#1169
Garland, J. A., D. H. F. Atkins, C. J. Readings, S. J. Caughey. "Deposition of gaseous SO_2 to the ground." Atmospheric Environment, 8:75-79 (1974).

The rate of dry deposition of sulphur dioxide to an area of short grass was obtained from measurements of the variation of concentration with height, using a new method to obtain turbulence parameters from temperature and wind speed profiles. The deposition velocity varied widely from time to time without any clear dependence on the weather, with a mean value of 0.0055 ms^{-1}. If this value applies to the countryside as a whole, the mean concentration found by Meetham (1950) of 41 $\mu g\ m^{-3}$, would indicate that about 25 per cent of the SO_2 emitted within Great Britain was deposited within the area of the country by dry deposition.
Source: 6

#1313
Gardner, W.S. "Ozone injury to tobacco plants in South Dakota." Plant Disease Rept., 57(2):106-110 (1973).

Ozone injury symptoms appeared on Turkish tobacco plants grown in a greenhouse and on Wisconsin 38 tobacco plants grown in field plots at Brookings, South Dakota in 1970. In 1971, ozone injury appeared on greenhouse and field-grown plants of the Bel-W3, Bel-C, and Turkish types. Ozone fleck

was most severe in southeast and east-central South Dakota. A decreasing amount of injury was observed in northeast, central, west-central, and southwest South Dakota. The Bel-W3 tobacco showed injury at eight locations, while Turkish, Bel-C and Bel-B were injured only in the eastern parts of the state. The Bel-W3 was a reliable monitor of air pollution episodes when plants were continuously produced and observed in the greenhouse at Brookings. New injury appeared on newly matured leaves and older leaves as dark gray to black flecks that turned brown to tan to white with age. Periodic ozone occurrences were recorded by new flecks appearing generally in tissue of younger age. Plant indicators for the pollutants peroxyacetyl nitrate, fluoride, and sulfur dioxide showed no injury in South Dakota.
Source: 1

#1485

Garratt, J.R. and G.I. Pearman. "Atmospheric carbon dioxide." Proc. Int. Clean Air Conf., Melbourne, Australia, 17-22 (1972).

Important sources and sinks of atmospheric carbon dioxide are described, and the carbon cycle is represented as a set of interacting reservoirs. Exchange rates between the main active reservoirs, viz., the atmosphere, surface ocean layer, and terrestrial biosphere are considered, and turnover times of CO2 molecules in each reservoir are deduced and compared with independent measurements. Measurements of atmospheric CO2 concentration indicate an increase in the presence of an increasing annual CO2 output from combustion of fossil fuels. The oceans appear to be an important sink for this CO2 excess, though they are capable of significant inputs of CO2 to the atmosphere, possibly over periods of decades. Recent studies on the climatic consequences of an increased CO2 content in the atmosphere indicate a small temperature increase for a doubling of CO2 concentration, but possible feedback effects are excluded. Further changes in the concentration of other atmospheric constituents could produce comparable absolute temperature changes of either sign.
Source: 1

#1484

Garratt, J. R., and G. I. Pearman. "CO_2 concentration in the atmospheric boundary-layer over southeast Australia." Atmos. Environ., 7(12):1257-1266 (1973).

Observations of atmospheric carbon dioxide at two sites in Southeast Australia made over a period of several months, together with data from two aircraft flights made in the lowest 3 km of the troposphere are described. The data indicate day-to-day variations in CO_2 content (midday values) at any one site are no more than 2-3% of the atmospheric value (5-10 ppm) and are related to changes in the air trajectory. Seasonal variations of similar magnitude are indicated, and depend upon the geographical location of the site, decreasing to near-zero as the coast is approached. The space and time variations of the near surface CO_2 content are consistent with the land surface of the southeast part of the Australian continent acting as a net surface sink, at least

over the observation periods (winter and spring). Little variation with height was observed in the CO_2 content in air of oceanic origin, whereas air of continental origin showed considerable variations of CO_2 with height over the first 2 km, related to surface effects. A simple boundary layer model utilizing the two-dimensional diffusion equation can be used to predict changes in the vertical CO_2 profile due to surface flux variations.
Source: 1

#1314
Garrec, J.P., R. Bligny, A. Bisch, and A. Fourcy. "Accurate fluoride determinations throughout polluted fir needles." Fluoride, 6(2):73-78 (April 1973).

Fluoride analyses were made of the surface tissues of polluted needles of fir trees by using microanalysis by proton nuclear reaction. Two distinct peaks of fluoride accumulation were established. The first in the extreme tip of tne needle S necrotic area, and the second in the narrow strip which separates the healthy from the injured tissue. The magnitude of these two accumulations and the distribution of fluoride throughout the needle is related to the age of the needle. The amounts of fluoride differ depending upon which side of the needle is measured, the upper surface takes up more fluoride than the lower one.
Source: 1

#1316
Garrec, J. P., E. Ligeon, A. Bontemps, R. Bligny, and A. Fourcy. "Exact localization of fluorine along polluted needles of Abies alba by proton microanalysis." (Localisation exacte du fluor le long d aiguilles polluees d Abies alba par microanalyse au moyen de protons). Text in French. J. Radioanal. Chem., 19(2):359-365 (1974).

The distribution of fluorine on and near the surface of contaminated needles of Abies alba was studied by porton bombardment, using direct detection of the alpha rays generated during the reaction of F(19) with oxygen. The method is rapid and has a sensitivity of 10 micrograms/g fluorine. Accumulation of fluorine in the necrotic apical zone of the needle in concentrations reaching up to 60,000 micrograms/g, and a slighter degree of accumulation in a narrow zone separation the necrotic from the intact zone of the needle were found. The fluorine concentration in the necrotic apical zone increased rapidly with age, while that in the boundary zone diminished and fell to zero after a certain age. The fluorine concentration was higher in the upper than in the lower surface of the needles.
Source: 1

#1315
Garrec, J.P., J.C. Oberlin, E. Ligeon, A.M. Bisch, and A. Fourcy. "Fluoride calcium interaction in polluted fir needles." Fluoride, 7(2):78-84 (April 1974).

The fluoride calcium interaction was investigated in the leaf tissues of fir needles growing in a polluted area. The fluoride and the Ca distribution were established in relation to the effect of the fluoride on the chemical forms of Ca. Simultaneous determination of fluoride and Ca by proton microanalysis revealed a simultaneous accumulation in the injured tip, and a large increase in the Ca level throughout the polluted needles. The ratio of the chemical forms of Ca also changes with the accumulation of fluoride; Ca oxalates particularly show an increase. There is a parallel deposition of fluoride and Ca in polluted needles which suggest precipitation of calcium chloride. The largest amounts of Ca and fluoride in equal proportions are localized in the injured area. This localization in the tips suggests a direct relation between the possible precipitation of CaF_2 and apical necrosis. The relationship also sggests that formation of CaF_2 represents either a mode of inactivation of the halogen or a disturbing factor in the cellular equilibrium of Ca.
Source: 1

#156
Gary, H. L. "Airflow patterns and snow accumulation in a forest clearing." West. Snow Conf. Proc. (Coronado), 43:106-113 (1975).

Compares the airflow pattern and the snow accumulation profile in a forest clearing. Although incoming snow, during periods of snowfall, at one time or another comes from all directions, the ultimate pattern of snow accumulation most strongly reflects the average duration and direction of air flow. Zone of maximum snow accumulation was near the center of the clearing. Minimum snow accumulation was along the leeward forest border. Both areas were characterized by low windspeeds, implying that low snow accumulations did not result primarily from windscouring. Greater snow accumulation in clearings results from 'stealing snow' from the forest.
Source: 7

#1317
Gehu, J.M., M. Bon, C. Delzenne, and F. Rose. "Essai de ca tographie de la pollution atmospherique acide dans la Nord de la France en relation avec la toxisensibilite des lichens epiphytes." (Cartography of acid atmospheric pollution in North of France in relation to toxisensitivity of epiphytic lichens). Text in French. C. R. Acad. Sci, Paris, Ser. D. 276(5):729-732 (January 1973).

The Nord, Pas-de-Calais, and Somme areas of France were divided into ten different zones of sulfur dioxide pollution on the basis of the Hawksworth-Rose toxisensitivity scale established for epiphytic lichens. Some 600 sites were chosen for the cartographic study. Progressive pollution gradient from the West to the East with major industrial and mining activity was observed. The site of the pollution peak was shifted as a function of the dominant wind direction. Pollution cartography by means of epiphytic lichens has the advantages over physiocochemical techniques of being more simple, flexible and economical.
Source: 1

#1109

Geisenderfer, R.D. "Filtering effect of vegetation on aerosol." (Unpublished M.S. thesis). Pennsylvania State College, 29 pp.

Of the many problems confronting man today in his constant struggle for healthier living conditions, the problem of air pollution is probably the most publicized. While much research is being conducted on smoke abatement, the author believes that present day research is overlooking the significance of vegetation in this problem. For example, it seems that no direct study has ever been made of the filtering effect of plants on polluted air, although such an effect has long been assumed to exist. It is with this purpose in mind that the author has selected this problem for his investigations.
Source: 8

#1318

Genderen, J. L. van. "Remote sensing of environmental pollution on Teesside." Environ. Pollut., 6(3):221-234 (April 1974).

The methods and procedures most useful for the detection of vegetation stress resulting from the various forms of environmental pollution were studied in the industrial area of Teesside, England. There is a need for a carefully integrated program of image analysis, as well as for field and laboratory methods. Sequential aerial multiband photography is an extremely useful technique for plotting the spread of industries and pollution with time, as well as for examining the changes in vegetation and land use. Color infrared film is considered to be the most useful remote sensing device for vegetation stress determination, since plants under stress are usually accompanied by a loss of infrared reflectance from the affected verdure. Image enhancement techniques are useful tools in delimiting certain areas under stress. The use of multiband photography together with other remote sensing techniques, can greatly assist in the determination of areas of vegetation stress.
Source: 1

#1319

Gentile, A.G., W.A. Feder, R.F. Young, and Z. Santner. "Susceptibility of Lycopersicon ssp. to ozone injury." J. Am. Soc. Hort. Sci., 96(1):94-96 (1971).

Accessions, breeding lines, and varieties of Lycopersicon spp. (tomatoes) and one accession of Solanum pennelli Correll (tomato) were evaluated for sensitivity to controlled concentrations of ozone and to ambient air at Waltham, MA. The plant material were exposed in different stages of development to controlled ozone concentrations of 0.25 ppm for 3 hr, 0.05 ppm for 2 wk, and to 0.10 ppm for 4 wk. Based upon the degree of foliar injury, the tested material was separated into tolerant, intermediate, and sensitive populations. The highest degree of tolerance was observed in L. esculentum Mill. and the highest degree of sensitivity in L. pimpinellifolium. Germination of pollen from inflorescences exposed to 0.10 ppm was reduced 40% in sensitive accessions of L. pimpinellifolium when placed

on artificial medium. No significant reduction was observed in the most tolerant accession of L. esculentum. Differences in percent germination were not observed when pollen of sensitive and tolerant accessions was placed on artificial medium and exposed to 0.10 ppm ozone for a 6 hour period. Reciprocal cross pollinations between exposed and unexposed populations led to normal fruit development with viable seeds.
Source: 1

#1483
Georgii, H.W. "Contribution to the atmosheric sulfur budget." J. Geophys. Res., 75(12):2365-2371 (April 20 1970).

Measurements of sulfur dioxide and sulfate-contained ae osols in the free atmosphere were conducted to extend earlier investigations of the sulfur budget and of the stratosphere sulfate layer. Examination of the chemistry in the free atmosphere by aircraft ascents was considered a first step in an attempt to explain the sources and the persistence of the stratosphere sulfur layer. It seemed of particular interest to investigate the possibility of aerosol formation within the troposhpere, which might constitute a constant source of sulfate aerosols that would grow by coagulation during extended residence in the stratosphere. An increase of the sulfate/sulfur dioxide ratio with altitude was observed. A hypothesis on the mechanism of sulfate formation in the troposhere in the presence of clouds is offered, along with new data on the background concentration of sulfur dioxide and sulfate aerosols in pure air. The sulfur dioxide concentration over the Atlantic Ocean was between 0 and 3 micrograms SO_2/cu m, and the sulfate concentration was around 2-5 micrograms/cu m.
Source: 1

#307
Georgii, H. W. "Das natuerliche aerosol in reiner und verunreinigter luft." [Natural aerosol in clean and in polluted air]. Schriftenreihe Ver. Wasser Boden Lufthyg. (Berlin), 30:13-18 (1970).

The anthropogenic, industrial, and radioactive concentration of gaseous and particulate trace elements in the atmosphere exceeds that of aerosol by one order of magnitude. A characteristic difference exists between the nature and composition of continental and maritime aerosols. Terrestrial sources of aerosol are volcanoes, forest fires, desert dust, anthropogenic and industrial emissions; a negligible cosmic source is dust from meteorites. In the northern hemisphere, industrial sources account for 30% of the aerosol components. Salt nuclei from the sea account for one fourth to one fifth of the nuclei which are instrumental in cloud formation. The number of giant maritime nuclei exceeds that of giant terrestrial nuclei; their concentration in the troposphere decreases exponentially with altitude. While the number of Aitken's nuclei within the stratosphere decreases to a count of 10 per cu m, large nuclei manifest an increasing tendency at an altitude of 18 to 20 km. The effect of industrials emission such as SO_2 over industrial areas is clearly measurable to an altitude of 700 m; beyond that, local differences disappear. In central Europe, a natural background aerosol no longer exists; it has been obliterated by numerous anthropogenic processes and differs widely from natural aerosols of uninhabited parts of Asia, Australia and North America.
Source: 1

#87

Georgii, H. W., E. Busch, and E. Weber. "Investigation of the temporal and spatial distribution of the emission concentration of carbon monoxide in Frankfort/Main." Reports of the Institute for Meteorology and Geophysics of the University of Frankfurt/Main, 66 pp. (1967).

This report presents new results of the distribution of the emission concentration of carbon monoxide in Frankfurt/Main. Simultaneous measurements of the Co concentration and of wind-distribution in different levels above the street were performed. The evaluation of the data was carried out in dependence of traffic-density, wind-velocity and wind-direction. The results show a diurnal trend in all levels, the amplitude of which is determined by the production-rate of the automobile exhaust gases and of the wind-distribution. There exists a great difference whether the measurement of carbon monoxide is carried out on the weather side or on the lee side of the street. On the basis of the results gained the mechanism of air-circulation in streets and of the ventilation of streets can be deducted.
Source: 8

#1489

Georgii, H.W. and W. Vitze. "Global and regional distribution of sulfur components in the atmosphere." Idojaras (Budapest), 75(5/6):294-299 (Sept./Dec. 1971).

New information on the global and regional distribution of sulfur dioxide and sulfates in atmospheric aerosols was obtained during cruises in the Atlantic Ocean and in a series of aircraft ascents in Germany. There were significant variations in the latitudinal distribution of sulfate in aerosols over the Atlantic but not in the latitudinal distribution of SO2. The background sulfate concentration varied between 0.5-2.5 micrograms/cu m; however, the advection of particles from the Sahara desert caused the background concentration to increase to 3-4 micrograms/cu m sulfate ion. The transport of sulfate-containing continental aerosols over long distances is thus a source of sulfate in ocean aerosols as well as the ocean itself. The sulfate ion/SO2 ratio was 1:1 to 5:1 in maritime areas; 1:1 to 1:2 in unpolluted areas of Europe; and 1:10 to 1:40 in heavily polluted Frankfurt. Based on these findings, the total mass of sulfate suspended in the atmosphere is of the same order of magnitude as the SO2 concentration in an unpolluted atmosphere far from anthropogentic SO2 sources. Over the ocean sulfate may exceed SO2 due to particle production at the ocean surface. The vertical distribution of sulfate-containing particles of different sizes was also investigated. At ground level 25% of the total sulfate was contained in particles smaller than 0.2 micron, but at 2500 m above ground 75% of the total sulfate was contained in this size class. Since the mass median radius of sulfate particles changed with altitude, 50% of the sulfate mass in the middle troposphere must be contained in Aitken nuclei.
Source: 1

#1320

Gerdes, R.A. "Effect of atmospheric hydrogen fluoride upon Drosophila melanogaster." Texas Agricultural and Mechanical Univ., College Station, Dept. of Genetics, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, 57 p. (Aug. 1967).

The effects of gaseous hydrogen fluoride on Drosophila melanogaster (flies) were investigated. The populations were exposed to different concentration of HF for various treatment periods, and the effects on fecundity, hatchability, fertility, longevity, and generation time were studied. All of the parameters except generation time responded significantly to the HF treatment, with a range of responses from lethality to relatively no effect. The lethal concentration varied with strains but was very low for all the strains In sublethal concentrations, the major treatment response was a function of treatment duration. Sublethal concentrations (less than 7.5% HF) caused measurable deleterious effects in the traits exhibited in the two strains. Oregon-r and yw, at the treatment levels and durations studied.
Source: 1

#787

Gerhold, H.D. and E.H. Palpant. "Prospects for breeding ornamental scotch pines resistant to air pollutants." Proc. Central States Forest Tree Improvement Conf. 6th, Carbondale, Ill. and St. Louis, Mo., 34-36 (1968).

A project is underway to develop methods of breeding ornamental trees with a genetically superior resistance to sulfur dioxide and ozone. Major attention will be focused on Scotch pine since the species is adaptable to a wide variety of sites and conditions over a wide variety of latitudes. Moreover, Scotch pine already has moderate resistance and the internal variability needed as the basis for further improvement. Breeding can be done conveniently in young, flowering plantations that contain an extensive collection of provenances representing most of the genetic diversity within the species. Important elements of the long-range plan are to find the best sources of resistance, to select intensively for the most desirable individuals at an early age, to find and use the breeding method that will produce an optimum combination of characteristics in the least time, and to develop a method for rapid multiplication of trees that have immediate usefulness. Two methods of selection, to be used in tandem, will be investigated. Two-yr-old seedlings will be fumigated under carefully controlled conditions in the nursery. Then survivors will be planted near pollutant sources for exposure under field conditions. After four growing seasons, evaluations of resistance and other traits will be completed. At this age the potential for rooting of cuttings is still high, and the next generation in the breeding program can be started within a few years.
Source: 1

#1901

Gerhold, H. D., and G. H. Plank. "Monoterpene variations in vapors from white pines and hybrids." Phytochemistry, 9:1393-1398 (July 1970).

Possibilities of altering the monoterpene composition of vapors given off by white pine twigs, bark and internal tissue by means of hybridization were investigated by gas chromatographic analysis of fifty-four trees. Fourteen peaks were detected in the chromatograms. These are designated heptane, alpha-pinene, beta-pinene, limonene, and unknowns F, G, H. J, L, and N. J is probably undecane and/or camphene, and L is probably myrcene and/or 3-carene, on the basis of relative retention times compared to those in the literature. F may be octane, and G may be nonane. Peaks A, B and C were caused by small amounts of contaminants from the container in which branch segments were warmed. Considerable variation in the chemical composition of vapors was found among the hybrids produced by crossing Pinus strobus with P. griffithii, P. koraiensis, P. flexilis, and P. ayacahuite. The intraspecific variation of P, strobus was nearly as large, however. Vapors from needles and bark closely resembled those given off by internal tissues, but exceptions were noted for several compounds.
Source: 1

#457

Gerlach-Tharandt, R. "Ueber forstliche versuche und erfahrungen. XI. Aufnahme- und aufspeicherungsfaehigkeit von schwefeliger saeure (SO2) und schwefelsaeure (SO3, Beziehentlich H_2SO_4) in den nadeln unserer gemeinen fichte." [Tests and experience in forestry. XI. Absorption and accumulation of sulfurous (SO2) and sulfuric (SO2) acid in the needles of our ordinary spruce]. Tharandter Forstl. Jahrb., (Germany), 76:224-232 (1925).

Absorption and accumulation of sulfur trioxide in spruce needles from two forest lots exposed to the same paper producing plant emissions for more than 40 years is illustrated by analytical data from studies carried out between 1890 and 1902. The factory is located in a valley on both sides of a creek; its emissions are carried by winds. Average SO3 values (where SO3 stands for the sum of both sulfur dioxide and sulfur trioxide) on lot no. I were 0.385%, 0.444%, and 0.526% (per 100 G dry matter) in 1890, 1897, and 1902 respectively. Lot no. II showed 0.289%, 0.430%, and 0.525% SO3 values in 1892, 1896, and 1902 respectively. Average SO3 accumulation in needle samples from lot no. I was 15% from 1890 to 1897, 18.5% from 1897 through 1902 and constitutes a total of 36.2% from 1890 through 1902. Samples from Lot no. II show accumulations of 48.7%, 21.9%, and 81.3% through the 1892/1896, 1896/1902, and 1892/1902 periods, respectively. Exposure of Lot no. II to pollutant emissions started eight years later than that of lot no. I. The enhanced effects upon Lot no. II are attributed to its topographic site and to its exposure to frequent winds. The generally increasing SO3 levels in the spruce needle samples is attributed to time and technological factors (increased charcoal consumption). Maximum SO3 accumulation levels in spruce needles before falling off cannot be deduced from these data.
Source: 1

#1170

Gifford, F.A. Jr., and D.H. Peck. "Surface deposition of airborne material." Nuclear Safety, 3:76-80 (1962).

Deposition of airborne material is measured on four different types of surfaces: grass taken from a known ground area; filter paper placed on a petri dish on the ground; leaves of dandelion or clover growing in an experimental area; and paper "leaves" attached to dandelion or clover. Deposition on natural and paper leaves were measured in a wind tunnel and tabulated. Dry disposition of activity on nuclei on horizontal surfaces is tabulated as well. A distinction was shown between the removal rate of an inert and a chemically active material. Vegetation, specifically grass and sage brush, brings about a much greater removal rate than bare soil on plate collectors. It is noted that this experiment doesn't show deposition on buildings and houses, or during specific weather conditions.
Source: 6

#1321

Gilbert, O.L. "The effect of SO_2 on lichens and bryophytes around Newcastle upon Tyne." Council of Europe, Committee of Experts on Air Pollution, Air Pollution Proc. First European Congr., Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 223-235 (April 22-27, 1968).

Deterioration of lichens and bryophytes on trees, asbestos roofs, sandstone wall tops, and in grassland was investigated in Newcastle upon Tyne by examining the plants along a 32-km belt transect stretched from an area of pure air to the center city, where the sulfur dioxide annual average is 200 micrograms/cu m. The majority of species decrease in abundance, vigor, and diversity as the town is approached. Ultimately, at an annual SO_2 average above 0.016 ppm, an area of very low species diversity is reached. Defined thus, a desert of about 500 sq. mi. is centered on the Newcastle Coalfield. It can be limited very precisely by mapping Grimmia pulvinata or Parmelia saxatilis. Two environmental factors can alleviate the effect of SO_2 pollution; shelter by causing a reduction in SO_2 levels and high pH, by influencing the degree of ionization and rate of oxidation of sulfite. Experimental evidence suggests that accumulation of sulfur in the thalli of lichens is an active biological process.
Source: 1

#369

Gilbert, O. L. "A biological scale for the estimation of sulphur dioxide pollution." New Phytol., 69:629-634 (1970).

By observing the distribution of lichens and bryophytes in an area where levels of SO_2 are well known it has been possible to produce a scale from which annual average levels of this pollutant can be estimated. Instructions on how to use the scale are given and its accuracy and possible usefulness are discussed.
Source: 7

#788
Gilbert, O.L. "The effect of airborne fluorides." In: Air Pollution and Lichens, B.W. Ferry, M.S. Baddeley, and D.L. Hawksworth (eds.), Toronto Univ. Press, Toronto, Chapt. 9, p. 176-191 (1973).

The effects of airborne fluorides on lichens is discussed. The toxicity of fluorides to lichens was established by field studies showing that the lichen flora in the vicinity of isolated point sources is severely impoverished, field transplant experiments, and fumigation experiments. Exposure to 13 ppb for 36, 72 and 108 hr causes chlorotic spots and curled margins; 65 ppb for 12 hr produces similar symptoms. Accumulation occurred during fumigation whether visible damage was produced or not. Fluoride damage is reported from Britain, Canada, France, Norway, and the United States. These studies all find F2 toxic to lichens, but there is no agreement on the order of sensitivity. The degree of shelter can have a major effect on the distribution of damage. There is evidence that species can better tolerate the pollution when growing in eutrophicated conditions. Lichens are useful indicators of the spread of F2 pollution from alumninum smelters.
Source: 1

#1322
Gilbert, O.L. "An air pollution survey by school children." Environ. Pollut., 6(3):175-180 (April 1974).

A criticism of biological scales for the estimation of air pollution has been that they can only be used by experts. A highly simplified scale was developed and used by school children (average age 13-14 years) to produce a picture of air pollution for Great Britain, including Scotland, which compares favorably with existing lichen zone maps. The survey used a booklet containing background information on clean and polluted air and an apparatus for carrying out some simple experiments. Since lichens show a wide range of sensitivity to sulfur dioxide, they are found in zones as a result of changes in the level of this pollutant. The children observed the growth of lichens on deciduous trees, acid stone, and alkaline stone to determine seven lichen zones corresponding to different levels of SO_2 pollution.
Source: 1

#555
Gilbert, O.L. "Effects of air pollution on landscape and land-use around Norwegian aluminum smelters." Environ. Pollut., 8(2):113-121 (February 1975).

Investigations around three aluminum smelters in Norway revealed that air pollution emanating from the works was affecting landscape and land-use for a distance of several kilometers. A zonal pattern of damage to the total flora is described in sufficient detail to act as a field guide for the recognition of this type of fume damage. Reasons for believing the observed effects to be due to fluorides are given and the visual and ecological consequences discussed. It is important that when expansion of the aluminum producing industry occurs this is undertaken in full realization of the possible consequences.
Source: 2

#789
Gilbert, O.L. "Further studies on the effect of sulphur dioxide on lichens and bryophytes." New Phytol, 69(3):605-627 (1970).

After comparing 16 aspects of their biology, it is clear that, despite wide differences in botanical affinity, bryophytes and lichens are similar in their response to sulfur dioxide. This suggests that these plants can colonize inhospitable habitats only by adaptations which possess an inherent susceptibility to air pollution. Extensive laboratory and field work has emphasized the controlling influence of habitat on the survival of species. One of the strongest modifying influences is shelter, which can greatly reduce SO_2 levels. Another influence is the effect of pH and buffer capacity. Lesser, but easily, recognizable, alleviation is caused by nutrient flushing. Evidence was found that late seral stages are more sensitive than pioneer ones. The water relations of a site were once thought to be important, but were found to have little effect on survival. Only where a continual seepage of alkaline water prevents pH gradients from developing in bryophyte colonies does it have a significant effect. The study of these habitats which allow sensitive species to partially penetrate build-up areas showed that this is due to special environmental factors. It is suggested that those habitats which are vacated first due to increasing SO_2 pollution possess physical attributes which emphasize the toxic effect.
Source: 1

#458

Gilbert, O. L. "New tasks for lowly plants." New Scientist, 46:288-289 (May 1970).

The occurrence and behavior of easily identified lichens and bryophytes can be used as an index of sulfur dioxide pollution, since SO2 kills them. As these lower plants range from very sensitive to highly resistant, they can be arranged to form a scale from which levels of SO2 can be estimated. Also, by mapping the distribution of selected species, the size and shape of an area affected by pollution can be determined. Ideally, these indicator species should be widespread, easy to recognize, and among them show a wide range of sensitivity so that the rate of fall off of pollution can be assessed. A table of SO2 estimates correlated to plant incidence is given, along with some examples of application of the principle. Pollutants other than SO2 have only barely detectable effects on lower plants, however, observations around aluminum smelters suggest that lichens are also useful indicators of fluorine pollution.
Source: 1

#368
Gilbert. O.L. "Lichens and air pollution." In: The Lichens, V. Ahmadjian and M.E. Hale (eds.), Academic Press, New York, 714 pp. (1973).

Reviews the history of research on lichens and air pollution effects. Discusses lichen deserts, their causes, and the resistance of various species of lichen. SO_2 seems to be the major pollutant although little work has been done on other pollutants. Habitat plays an important role in determining survival; some examples: shelter, pH, nutrients, water relations, and age of substratum. Also briefly discusses use of lichens as estimators of pollution.
Source: 7

#1283
Gillette, Dale A. "On the production of soil wind erosion aerosols having the potential for long range transport." J. Rech. Atmospheriques, 8(3-4):735-744 (July-Dec. 1974). International Symposium on the Chemistry of Sea/Air Particulate Exchange Processes, Nice, France, Oct. 4-10, 1973.

The production of soild wind erosion aerosols expressed as vertical flux of particulate matter was measured for several wind speeds on two soils of distinct textural types. Erosion conditions for the two soils such as soil moisture, surface roughness, cloudiness, and vegetative residue are very similar. The vertical fluxes of aerosols are described by the relationship vertical aerosol flux alpha (wind speed/threshold erosion wind speed) to the gamma power, where wind speed is greater than threshold wind speed and where gamma is greater than 3 and is larger for the soil having more silt content per unit mass. Increased disintegration of soils aggregates with increased sandblasting causes larger proportions of particles with greater than 10 micron in the injected particulates. Aggregates composed of fine particles yield more fine particles when they are disintegrated than aggregates having smaller proportions of fine particles.
Source: 1

#1282
Gillette, D. A., I. H. Blifford, Jr., and C. R. Fenster. "Measurements of aerosol size distributions and vertical fluxes of aerosols onland subject to wind erosion." J. Appl. Meteorol., 11(6):977-987 (September 1972).

To assess wind erosion as a source of atmospheric soil particles, vertical aerosol fluxes near the ground in an eroding field were computed by assuming a vertical transport mechanism similar to that for momentum. Aerosol gradients were measured by totalizing-three-cup anemometers located 1.5, 3, and 6 m above the ground. Information on the aerosol size distributions and quantity in the size range between 0.3 and 6 micron radius was obtained from a variety of erosive conditions in a field in rural Nebraska. The relation of the aerosol size distribution in this range to the size distribution of soil was determined. Horizontal soil particle fluxes were measured and compared to the vertical fluxes. The measured erosion was compared to erosion predicted by an empirical formulation based on the parameters of soil moisture, field length, vegetative residue, mechanical stability, ridge roughness, and vertical momentum flux. Measurements of aerosol size distributions from ground level to 11.9 km on two occasions when soil was very moist and no vertical flux of aerosol was observed showed the aerosol size distribution to be constant in shape and in concentration from the ground to the top of the mixing layer. Above the mixing layer, concentration decreased for all particle sizes above the mixing layer up to the base of the tropopause where an increase in concentration for the smallest particles and a decrease in concentration for the largest particles were observed.
Source: 1

#277
Gilpin, A. "Air pollution: causes and effects." In: Air Pollution, St. Lucia, Australia, University of Queensland Press, 1971, Chapt. 2, p. 3-12.

Sources of air pollution may be either natural or man-made. They may either be primary emissions from industrial, domestic, or automotive source, or they may be formed in the atmosphere by interaction (photochemical or other wise) among primary contaminants or between contaminants and normal atmospheric constituents. The causes and effects of photochemical smog are presented with the case of Los Angeles smog as an example. The ability of the atmosphere to naturally ventilate itself is explained, and, as is pointed out for Brisbane, Australia, natural geographic variations can cause the failure of these mechanisms to adequately disperse pollutants. A discussion of the long-term effects of air pollution on health points out the difficulty of establishing the precise role of pollutants in causing or contributing to ill-health, bronchitis, lung cancer, and Tokyo-Yokohama asthma, and the effects of tetraethyl lead are considered. Other degradative effects of air pollution discussed are corrosion, effects on stonework, livestock, crops, and climate.
Source: 1

#1323
Gish, C. D., and R. E. Christensen. "Cadmium, nickel, lead and zinc in earthworms from roadside soil." Environ. Sci. Technol., 7(11):1060-1062 (Nov. 1973).

Residues of heavy metals in earthworms and soils were compared with distance from roadway and traffic volume. Cadmium, nickel, lead and zinc in soils and earthworms along two Maryland highways decreased with increasing distance (10, 20, 40, 80, and 160 ft) from the roadway. Metals were quantified by atomic absorption spectrophotometry. Metal residues were higher at the location each highway where traffic volume was greater. Correlations between residues in earthworms and soil decreased with decreasing atomic weights (Pb greater than Cd greater than Zn greater than Ni). Metal residues in soils were positively correlated with quantities of soil organic matter. Earthworms accumulated up to 331.4 ppm of Pb and 670.0 ppm of Zn concentrations which may be lethal to earthworm-eating animals.
Source: 1

#1324
Gisiger, L. "Versuche zur experimentellen Abklaerung der Fluroschaeden auf Pflanzen." (Experimental study of fluorine damages in plants). In: Toxicologie des Fluors, T. Gordonoff (ed.), Verlag Schwabe and Co., Basel/Stuttgart, p.164-178 (1964).

The fluorine-inflicted plant damages as occur near aluminum works were studied in pot tests in winter wheat and clover. Plant grown in soil to which sodium and potassium fluorides had been added took up less fluorides, and these fluorides were less soluble than in soils to which the corresponding cryolites had been added. Fluoride doses of up to 180 mg% caused no noticeable loss in yield. Spraying the plants with fluoride

solutions resulted in high fluoride contents on the leaves reaching up to 1% without noticeable loss in crops and necrosis. In plants sprayed with fluorides in field tests, damages similar to those occurring in fluorine polluted areas were observed in rainy weather. Discoloration of the glumes resembling Septoria, and losses in crops occurred in winter wheat sprayed with high concentrations of sodium fluoride solution during the late stages of flowering. Slow increase in the degree of necrosis of the leaf edges in clover smoked with 0.25% hydrofluoric acid by volume for several nights was observed. At the same time, the fluorine content in the leaves increased from a background value of 2.6 mg% to 64 mg% after one treatment, to 104 mg% after two treatments, and to 360 mg% after eight treatments.
Source: 1

#190
Gisiger, L. "Ueber den gehalt der boden an fluor und dessen aufnehmbarkeit durch pflanze und tier." [On the fluorine content of soils and its absorption by plants and animals]. Schwiez. Landwirt. Monatsh., 44(6): 221-230 (June 1966).

Soil samples in Fricktal in the Canton of Aargan, Switzerland, were studied to determine if a fluorine increase on the soil surface was traceable to the emissions of an aluminum plant. Guided by the literature and a similar study made in 1962 to investigate the influence of the clay content of soil on its F content, the soil was examined in accordance with the dominant wind direction from the aluminum plant. Soil was studied at depths of 0. to 2.5 cm and 2.5 to 10 cm. Examination of F content in representative vegetation evidenced no recognizable dependence from 26 to over 100%mg of the soil samples studied. Among the many results of the research discussed and presented in tabular format are the findings involving feeding hay to sheep and determining F retention and absorption by analyzing their urine and excrement. Fluorine toxicity of the soil yielded a sodium fluoride equivalence of approximately two-thirds. The specific phases of the research discussed are: solubility of F in soil, absorption of F by plants in soils of differing F content, and F resorption through pollution as measured in ruminants.
Source: 1

#1325
Glater, Ruth Ann Bobrov. "Smog damage to ferns in the Los Angeles area." Phytopathology, 46(56):696-698 (Dec. 1956).

A new symptom was observed in ferns in response to the polluted air of Los Angeles. In the field, and in the lab, fern leaves showed characteristic markings following a period of high smog intensity. These symptoms were quite distinct from those previously reported on other plants. Damage manifested itself as a tan spotting of leaves, followed by local or general dehydration of the affected areas, ending in necrosis of the entire leaf. The typical fern leaf or frond is large, pinnately compound, and often dissected. The cells are large and many armed, forming a network around a tremendous amount of internal air space. Stomata are limited to the lower leaf surface. About 24 hours following the incidence of smog tan lesions, commonly near the smaller veins, appear on the leaves. The general response of the cells of fern leaves to smog is discussed.
Source: 1

#1936

Glater, R. A. B., and L. Hernandez, Jr. "Lead detection in living plant tissue using a new histochemical method." J. Air Pollution Control Assoc., 22(6):463-467 (June 1972).

A simple and rapid method for identifying and distinguishing lead from other heavy metals in living plants has been developed using sodium rhodizonate which forms a scarlet precipitate with lead at approximately pH 2.8. Hand sections of plant tissues are treated with rhodizonate reagent, buffered, and examined microscopically. Those cells and tissues contaminated with lead turn scarlet-color intensity being directly related to concentration. Lead may be detected in quite low concentrations (in the order of 10 ppm) and may be observed in situ; its entry and movement through plant can thus be followed. A disadvantage of the method is that the color does not persist beyond a few hours. In an area of moderate traffic of Downey, California (Southeast Los Angeles), lead was found abundantly on leaves as well as on roots of garden-grown lettuce; origin of this lead presumed to be from car exhausts.
Source: 1

#1968

Goddard, A.J.H., R.E. Holmes, and H. Apsimon. "Computation and mapping of the dispersion and herbage uptake of gaseous effluents from industrial plants." Society of Engineering Science, Pollut. Eng. Sci. Solutions, Proc. Int. Meet. Soc. Eng. Sci., 1st, Tel Aviv, Israel, 1972, p. 548-563 (June 12-17, 1973).

Computer routines which enable rapid computation of air contamination downwind from complex release patterns are described. Routines exist whereby isopleths of ground level air concentration averaged over varying time intervals are automatically plotted for rapid appraisal. In addition, integrated air concentrations can be predicted for speicfied locations, such as air sampling stations, and these results printed out. Further routinas compute the levels of contamination within plant and animal species as a function of time during the exposure. As an example of the application of some of the routines, the release of fluorides from aluminum smelting is discussed. The significance of aluminum smelting in the United Kingdom and emissions from the notional smelter are described. The relative significance of air and pasture contamination with fluorides, human and animal toxicity, and plant toxicity are reviewed. Calculation of dispersion, computer mapping of concentrations of fluoride at ground level, and calculation of time-dependent herbage levels are discussed for the example of fluorides released from an aluminum notional smelter. The numerical results illustrate the application of this ecosystem pollution program to the initial analytical stages of this type of environmental study. The program provides rapid and readily comprehensive predictions of air and herbage contamination. By virtue of the low cost of operation, computations can be made to relate herbage monitoring and district air sampling results to specific variables such as significant changes inweather, seasonal changes in herbage growth rates, and changes in the release pattern of fluorides from the plant.
Source: 1

#459
Godzik, S. "Absorption of 35-SO2 and its localization in the leaves of certain trees." Polish Academy of Sciences, Zabrze, Research Inst. of Upper Silesian Industrial Region, Mater. Miedzynorodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland. p.63-77 (Sept 9-14, 1968).

A comparative study was conducted of sulfur dioxide (35) absorption by leaves and needles of four tree species: Pinus silvestris, Picea excelsa, Quercus robus, and Betula verrucosa. Considerable differences in intensity of SO2 absorption were observed between particular species and also, in the case of Pinus and Picea, between needles of different ages. The greatest quantity of sulfur was absorbed by Betula leaves; the least, by Picea needles. In natural field conditions, Betula is highly resistant to the action of SO2 and Picea highly susceptible. The results, therefore, indicate that the susceptibility of a particular species is not governed by the amount of SO2 absorbed in a given time. Localization of absorbed sulfur was nonuniform and did not change significantly after 24 hrs, indicating a more or less permanent bonding by the plant material.
Source: 1

#999
Godzik, S. "Verlerchende untersuchungen uber die Aufnahma von Schwefeldinoxyd aus der Atmosphere durch einge Arten der Baltung pinus."(Comparative investigations on the uptake of SO_2 from the atmosphere by certain species of genus Pinus.) Witt forstl Bundes - Versuchsanstalt Wien 97:319-334. Also English summary for London. Res. & Dev. Pap. #82-25 (1971).

The investigations were made in hermetically sealed chamber on detached shoots of the following species: Pinus sylvestris, P. rigida, P. nigra, P. strobus and P. mughus. The plant material came from a place with slight air pollution by dust and sulphur compounds. The detached shoots were treated with low concentrations of SO_2 (about 0.2 ppm) labeiled with radioactive sulphur, with continuous air through-flow. The degree of radioactivity of the one-year needles was the measure for the SO_2 uptake. The results were expressed by reference to the dry matter, respiration rate and chlorophyll content of the individual species.

Differences were found in the amount of SO_2 taken up by the needles of the different species, and significant differences were found between individual needles of the same species. The results were statistically analysed.

For some species we determined the amount of labelled SO_2 in different sections of the needles (along the length of the needle). In Pinus sylvestris, a distinct accumulation of labelled SO_2 was observed in the tip zones of the needles.
Source: 5

1583
Godzik, S. "Verglechende untersuchungen ueber die aufnahme von schwefeldioxyd aus der atmosphaere durch einige arten der gattung pinus." [Comparative investigations on uptake of sulfur dioxide from the atmosphere by certain species of the genus Pinus]. Mitt. Forst. Bundesvers., 97: 319-334 (1972).

Investigations were performed to determine the uptake of sulfur dioxide from external air by needles of varying ages from selected pine species and to determine the content of absorbed SO2 in different needle parts. The tests were performed in a hermetically sealed chamber on detached shoots of Pinus sylvestris, P. rigida, P. nigra, P. strobus, and P. montana. The plant material came from a place with slight air pollution caused by dust and sulfur compounds. The detached shoots were treated with low concentrations of labelled SO2 (about 0.2 ppm) with continuous air through-flow. The degree of radioactivity of the one-year needles was the measure for the SO2 uptake; and the results were expressed by reference to the dry matter, respiration rate, and chlorophyll content of the individual species. Statistical analysis of the results revealed significant differences in the amount of SO2 taken up by the needles of different species and between individual needles of the same species. Comparison between quantity of SO2 uptake and the chlorophyll content (and/or respiration intensity) showed no relation among the results. A distinct accumulation of labelled SO2 was observed in the tip zones of Pinus sylvestris needles, and the uptake of SO2 appeared to be largely dependent on physical and chemical qualities of the plant tissue rather than the vital processes. The quantity of an absorbed toxic substance (SO2) is not the only cause of varying sensitivity among plants of a single genus. Data are presented for the radioactivity, chlorophyll content, and respiratory intensity of the experimental pinus species.
Source: 1

#1327
Godzik, S. and Z. Harabin. "Waldbestaende im Raume Katowice und Myslowice zu Ende des XIX Jahrhunderts und gegenwaertig." (Forests in the Katowice-Myslovice area at the end of the 19th century and today). Text in German. Polska Akademia Nau, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Knof., Wplyw Zanieczyszczen Powietraa na Lasy, 6th, Katowice, Poland, p. 355-370 (Sept. 9-14, 1968).

In 1893 Reuss published a study of pollution damage to forests in the Katowice-Myslowice industrial district which contained a wealth of information about the prevailing condition, composition, quality, and other characteristics of the forests at that time. To the extent possible, this study was duplicated recently and results compared. The forest area investigated by Reuss and in the recent study was 3042 ha. The yearly SO_2 emission estimated by Reuss was 35,600 tons. The comparison of studies indicates (1) increased emission in the last few decades has considerably reduced the periodic increase in tree diameter of tres of comparable age (while in 1968 the loss of the periodic, 3-year increase in diameter of 43-year old pine trees due to pollution was 46% while the same decrease on 43-year old pine trees 50 years ago was only 3%), (2)that a gradual dying off of whole stands is taking place, and (3) that fir trees are less resistant to pollution than pine trees. This last conclusion is based on the change in the composition of the forests. The continued cultivation of hundreds of hectares of dying unproductive tree stands exposed to extreme pollution levels is senseless and immediate replacement should be considered.
Source: 1

#1329
Godzik, S. and H. F. Linskens. "Concentration changes of free amino acids in primary bean leaves after continuous and interrupted SO_2 fumigation and recovery." Environ. Pollut. 1(7):25-38 (July 1974).

Youngbean plants were fumigated with 0.1 + or - 0.1 ppm sulfur dioxide for 6, 12, or 24 hr/day. Control plants were treated in identical chambers without SO_2 in the air stream. In the primary leaves of the beans, the concentration of free amino acids changed dramatically after fumigation with SO_2. In general, exposure to SO_2 increased the total amount of free amino acids. Reduction of aspartic acid and glutamic acid and increase of ammonium and some other amino acids were the most characteristic features of SO_2 fumigation. After a 92 hr recovery, a substantial decrease in the concentration of total amino acids occurred, although it did not reach the control level. After shorter periods of treatment with SO_2, the recovery was more complete. The SO_2 reduced protein synthesis in fumigated plants in comparison with control plants. After recovery, the protein content increased again to the control level in plants which had been treated up to 6 hr/day. Longer fumigation periods always resulted in a decrease in the protein concentration. Some of the observed long duration phenomena could be noted after only 1 hr of exposure. Changes in the concentrations of the free amino acids were observed even when SO_2 fumigation had not yet produced any visible injury to the leaves. It seems possible to use changes in the amino acid concentration for analyses of sublethal hidden injuries caused by SO_2 fumigation.
Source: 1

#1328
Godzik, S., and Z. Piskornik. "Oddzialywanie zanieczyszczen powietrza na rosliny." (The effect of air pollution on plants). Translated from Polish. Leo Kanner Assoc., Redwood City, Calif., 16 p., Nov. 1972. Wiad. Bot., 13(4):239-248 (1969).

The effect of air pollution on plants is reviewed. Pollutants discussed included sulfur dioxide, hydrogen fluoride, fluorine and its compounds, nitrogen oxides, ozone, chlorine and its compounds, and ammonia. The sources of each of these pollutants, their specific properties, and their effects are listed. Plant damages elicited by air pollutants are divided into acute damage, chronic damage, and invisible damage. Changes occurring during plant injury are described.
Source: 1

#191
Gonzalez, S. de Haro. "Humos fabriles e industriales y los danos que pueden causar a la vegetacion circundante." (Industrial fumes and the damage they can cause to the surrounding vegetation). Translated from Spanish. Ion (Madrid), 3(27):621-627 (Oct. 1943).

The damage caused to vegetation by industrial acid fumes, their prevention, and procedures for their chemical analyses are discussed. Damage to plants, animals, and humans from industrial sources is caused by acid flumes, metal-

lic chlorides and sulfates from the iron and steel industry, the chlorides sulfites, and sulfates of soda from boiler industries and from steam generators, calcium from lime ovens, ash from the manufacture of calcinated sodas, and the sulfur dioxide from the combustion of firewood for the manufacture of charcoal. Evidence of injury in plants is raw burns or an unhealthy appearance due to chronic or slow intoxication. All salts of sulfurous acid are harmful to living organisms, and prolonged inhalation of SO_2 in doses of from 0.5/1000 can cause serious biochemical injuries as well as irritation of the mucous membrane. Methods of determining quantities of pollutants include: five methods for sulfur trioxide in the air, four for sulfurous acid, hydrochloric acid in plants, and chlorine in ashes. Damage from acid fumes can be avoided by condensation;decomposition of SO_2 by hydrogen sulfate; use of metal residue; gas scrubbing; high chimneys; and special installations based on Isaachsens formula. This is the most practical method and involves increasing the quantity of gases by air by a ventilation system.
Source: 1

#1281
Goodman, G. T., and T. M. Roberts. "Plants and soils as indicators of metals in the air." Nature, 231(5301):287-292 (June 4 1971).

A study was conducted in Swansea, Wales to obtain some relative estimates of the total aerial burden of metals presumed to originate indirectly from former industry and directly from present day urban-industrial sources. Sampling and analysis were conducted for zinc, lead, cadmium, copper, nickel, and magnesium in the moss Hypnum cupressiformi, the grass Festuca Rubra, and in surface soils. Three transects, the Gower, Swansea, and Neath transects, were sampled along with the Gwendraeth Valley. The results show similar geographical trends for the metal examined. The concentrations of metal compounds increased in soils, Festuca, and Hypnum downwind of the Swansea urban industrial complex. The values in the two rural transects, Gower and Gwendraeth, contrasted sharply with the values of the Swansea transect. The results indicate that surface soils, Festuca, and Hypnum can be used as indicators and integrators of aerial metallic pollutants. Some applications of this method of sampling for agriculture and medicine are discussed.
Source: 1

#1280

Goody, R.M. and C.D. Walshaw. "The origin of atmospheric nitrous oxide." Quart. J. Roy. Meteorol. Soc., 79(342):496-500 (Oct. 1953).

The homogeneous chemical reaction $N2 + O3$ yields $N2O + O2$ has been proposed to explain the production of nitrous oxide. The rate of this reaction was estimated by mixing nitrogen and ozone in an absorption tube, measuring the ozone decay from the absorption in the Chappuis band and the nitrous oxide formed from the intensity in the 7-8 micron band. The calculated rate coefficient was 5 times 10 to the minus 28th power cc/sec at 19C, which is too slow, by a factor of 40, to account for observed concentrations of atmospheric nitrous oxide. When an estimate was made of the total rate of

production of nitrous oxide in the atmosphere by this reaction, the rate was found to be a minimum for an activation energy of 13 kcal/g-mol and to be within a factor of 2 times 10 to the 9th power molecules/sq cm/sec for activation energies between 2 and 38 kcal/g-mol. The actual activation energy is probably within this range since simple kinetic theory requires a value between 20 and 30 kcal/g-mol for the assumed rate coefficient. If this conclusion is correct, the average magnitude of the nitrogen cycle between earth and atmosphere is probably not less than 10 to the 11th power sq cm/sec. The results suggest that bacterial reactions in the soil are a more important source of atmospheric nitrous oxide than homogeneous gas reactions.
Source: 1

#556

Gordon, C.C. "Implications of air pollution in forest land planning." Proc. Soc. Am. For., 247-253 (1974).

Hard and loose data is presented on what the energy crisis means to forest land planning during the next 30 years. Three hypothesis' are discussed: (1) energy production will continue to double every 10 years for the next 30 years; (2) this doubling will be accomplished primarily from the utilization of our coal resources; (3) current and future decision makers for air and water pollution problems of federal regulatory and enforcing agencies such as EPA and the Justice Dept. will be as inept in protecting the biological systems of our country from air and water pollution damage as they have been in the last 73 years.
Source: 2

#287

Goren, S. "Plants pollute air." J. Air Pollution Control Assoc., 9(2): 105-109 (August 1959).

An air pollution incident is recounted as a result of a freak, record-breaking rainstorm inundating a large area of a succulent plant growth which subsequently decomposed anaerobically. Drainage in the past was always adequate for the usual rainfalls and tle attention had been given to upkeep of the engineered drainage system. This incident with its resultant air pollution problem emphatically demonstrated the need for an adequate drainage system through engineering means and its proper maintenance where the natural drainage is inadequate.
Source: 1

#1482

Gorham, E., and A. G. Gordon. "The influence of smelter fumes upon the chemical composition of lake water near Sudbury, Ontario and upon the surrounding vegetation." Can. J. Botany, 38:477-487 (1960).

The sulfate and calcium contents and the pH of surface waters of 102 lakes and ponds in the Sudbury metal smelting district were analyzed to determine

the effects of the nickel and copper smelter fumes on the chemical composition of the lake waters. Sulfur pollution was frequently high within about 5 mi of the three smelters, with sulfur concentrations for the ponds at more than three times the normal values, and three ponds with more than ten times these values. Outside a 15-mile distance, the influence of smelter pollution on sulfur contents of the waters was negligible. Many of the polluted waters were strongly acid, with pH values as low as 3.3. Sulfuric acid from air pollution also increased weathering of calcium from soils and rocks, increasing the calcium ion content not only in the waters above pH 6 but also in those below pH 5. Damage to terrestrial vegetation was frequently marked within about 5 miles from the smelters, with severe damage within a 2-mile area.
Source: 1

#1330
Gorham, E., and A. G. Gordon. "Some effects of smelter pollution upon aquatic vegetation near Sudbury, Ontario." Can. J. Botany, 41:371-378 (1963).

A floristic survey of 29 lakes and ponds near Sudbury, Ontario was undertaken to examine the effect of smelter pollution upon aquatic vegetation. The numbers of submerged and floating macrophyte species present in the ponds and lakes were inversely related to the concentrations of dissolved sulfates, which rose sharply within about 4 to 5 miles of the smelters. Although pollution often leads to strong acidification, the numbers of species were low even where the sulfuric acid was almost totally neutralized and the water was above pH6. Because sulfate ions are unlikely to be toxic at the levels encountered, and since pollution also increases the concentration of heavy metals in the water, it is suggested that the water may reach toxic levels near the smelters. Leptodictyum riparium and Eleocharis acicularis v. submersa seem to be the most tolerant species with regard to smelter pollution, while Utricularia vulgaris and Potamogeton epihydrus v. nuttallii appear to be rather sensitive to it.
Source: 1

#691
Graef, W. "3,4-Benzpyren als wachstrumsfaktor bei pflanzen." [The role of 3,4-benzopyrene in the growth of plants]. Arch. Hyg. Bakteriol. (Munich), 148:489-492 (1964).

The possibility of absorption and accumulation of cancerogenic hydrocarbons from soil by culture plants was studied. Plants important for human nourishment were grown on soil as well as in hydrocultures fertilized by 3,4-benzopyrene acid materials containing it. The content of benzopyrene in ripe plants or its fruits was compared with results of unfertilized control plants. Benzopyrene water solution was prepared from its acetone solution in maximum achievable concentration of 10 grams per liter of water. The solution was characterized by intense blue-violet fluorescence. Lettuce, cauliflower, turnips, and other plants were grown in hydrocultures with 10 grams of benzopyrene per liter and on soil cultures watered daily by benzopyrene solution in distilled water of the same concentration. Benzopyrene disappeared from nutrients hydroculture solutions within 8 days, plus indicating its absorption of plants. Acceleration in growth of turnips in fertilized hydrocultures and soil was observed in comparison with control plants.
Source: 1

#1331
Granger, J.M. "Computer mapping as an aid in air pollution studies: Montreal region study." Sarracenia, 15:43-83 (Jan. 1972).

A technique is described for evaluating the pattern and intensity of urban air pollution in the Montreal region using computer mapping of epiphyte sensitivity. The Montreal region is divided into two areas, rural and urban, with the boundary line being approximately 10 mi from the city center. Regression analysis is used to relate the index of atmospheric purity with the number of epiphytes per station. The land use intensity index and the number of epiphytes per station are also correlated. Regression analysis indicates that the variation in index of atmospheric purity is almost completely explained by the variation in the number of epiphytes, with a 97% degree of information being retained. Twin selection of four species (recorded by presence and coverage only) offers a degree of information retention of 91.4% in the urban area and 95.7% in the rural area. The appropriate spread of the two selections, explaining at least 80% of the index of atmospheric purity, fits a grid with a spacing of 1 mi in the urban area and 2 mi in the rural area. About six-sevenths of the urban values fall into the most polluted category, assuming an equal value range over eight categories. This occurs for an urban density threshold of about 28 persons/acre.
Source: 1

#192
Grennard, A. "Svaveldioxid - aktiv miljovard eller politisk taktik?" (Sulfur dioxide - Active environmental protection or political tactics?) Tek. Tidskr., 10:41-44 (1972).

The tendency to blame acidification of soil and water on sulfur dioxide emissions is criticized. Forest soils have PH values as low as 3.5-4. The sulfur deposition is 9 kg/ha yearly. However, no negative effects due to depositions of 100 kg of S/ha were determined. The estimated 0.4% growth reduction in forests, may be due to a great number of factors; no casuality between the former and SO2 has been demonstrated. The same applies to the acidification of lakes, where the assertions are based on measurements performed at a single lake over a one-year period. On the other hand, investigations revealed the need of certain soils and vegetation for sulfates and SO2. The situation in Sweden regarding air pollution due to SO2 is, moreover, better than in any other highly industrialized country. Thus, the measures taken to control SO2 emissions by reducing the sulfur content in oil were both immature and biased and could be of serious economic consequences. The forceful drive against SO2 may have served to divert attention from other environmental problems.
Source: 1

#460
Greszta, J., and J. Olszowksi. "The inflow of air pollution upon the growth of a common pine tree and a black pine tree." Polish Academy of Sciences, Zabrze, Research Inst. of Upper Silesian Industrial Region, Mater. Miedynarodowej Konf Wplys Zanieczyszczen Powietrza na Lasy, 6th, Katowice,Poland, p. 337-352, Sept. 9-14, 1968.

Comparative measurementssof branch development in common pines and black pines growing in similar climates and soils showed that the black pine is less damaged by smoke and gases. The species exhibited better acclimatization and greater increase in height, diameter, and volume development. A factor responsible for its resistance to industrial air pollution is bark thickness, which is 100-200% greater than on common pines.
Source: 1

#1332
Griffin, S. W. and B. B. Bayles. "Some effects of fluorine fumes on vegetation." In: Air Pollution, U. S. Tech. Conf. on Air Pollution, L. C. McCabe, ed., McGraw-Hill, New York. Chap. 10. p. 106-115 (1952).

Peach, apple, wild black cherry, Norway spruce, buckwheat, tomato, and corn plants were fumigated with relatively low and moderate concentrations of hydrofluoric acid gas in order to determine concentrations that might cause injury to various species, the appearance and character of injury, and the absorption of fluorine by plants. A wide variety of soil, meteorologic, and plant variables are noted that must be considered in interpreting the data from these tests. The leaves of peach, wild black cherry, buckwheat, tomato, and corn are very susceptible to acute damage when exposed to small amounts of hydrofluoric acid in the air. Apple foliage was less susceptible. Acute leaf injury resulted from fumigation at night as well as in daylight, although the injury was less. Pin-point chocolate-colored lesions produced at the tip ends of peaches served as the entry point for fungi which caused rotting. Fluorine content of leaves was markedly increased, but even relatively heavy exposures caused little increase in the fluorine content of the fruit. Exposure of peach trees for a few hours to hydrofluoric acid gas concentrations as low as 0.05 to 0.1 ppm may cause acute damage to a small percent of the leaves, but that higher concentrations or longer exposure are required to cause twig or shoot damage. The usefulness of buckwheat and various coniferous species as indicators of fluorine and other toxic gas pollution is discussed, as well as the fluorine content of soils. Lime applied to soils to which fluorine had been added greatly reduced the uptake of fluorine from the soil and prevented plant injury.
Source: 1

#193
Grill, D. "Optische veraenderungen in homogenisaten SO2 - geschaedigter fichtennadein." [Optic changes in homogenates of SO2 - damages spruce needles]. Int. J. Environ. Anal. Chem., 1(4):293-300 (May 1972).

Filtrates of spruce needles (Picea abies) were analyzed spectrophotometrically. The filtrates showed ultraviolet absorption maxima in the wavelength range of 2630277 nm, which was caused by Phenolic compounds present in the spruce needles. Special attention was paid to p-oxyacetophenone, both as a aglycon (lambda max, 275 nm) and as the glycoside picein (lambda max, 263 nm). The position of the ultraviolet absorption maximum depended on both seasonal and external influences, especially sulfur dioxide, on the spruce needles. Comparison of the maxima of ultraviolet absorption for exposed and non-exposed needles during the summer revealed significant differences which can be used as an additional aid to diagnose gas damages by air pollutants.
Source: 1

#790
Grill, D. "Elektronenmikroskopische Untersuchungen an SO_2 belasteten Fichtennadeln." (A study of SO_2 fumigated needles of spruce by scanning electron microscopy). Text in German. Phytopathol. Z., 78:75-80 (1973).

Spruce needles from a sulfur dioxide-damaged area were studied by means of scanning electron microscopy. Sulfur dioxide, even when dissolved in water as sulfurous acid, never caused corrision of the surface of the needles, while the wax structures on the needle surfaces were affected. Young needles showed an aggultination of their wax tubes, which is indicative of premature aging due to SO_2. Older needles showed, however, a more aggregated and grained wax structure. Smoke-damaged needles were unable to produce any more wax. The effect of SO_2 was most manifest in the oldest needles.
Source: 1

#462
Grill, D. and H. Esterbauer. "Wasserloesliche Sulfhydrilverbindungen in gesunden und SO2-geschaedigten Fichtennadeln." (Water-soluble sulfhydryl compounds in intact and SO2-damaged pine needles). Society for Ecology, Proc. Conf. Load Loadability Ecosystems, Giessen, West Germany, 155-156 (1972).

The cystein-Sh and gluthathione-SH contents in intact and sulfur dioxide-damaged pine needles were analyzed by comparative investigations. While both the ratio of the cystein-SH to the glutathione-SH, and the annual variations in the total sulfhydryl content are similar in intact and SO_2 damaged pine needles, the total sulfhydryl content in SO_2 damaged needles in summer is twice that found in intact needles in summer. The corresponding values measured in winter are up to four times higher in SO_2 damaged needles than they are in intact needles. Results of chemical needle analyses from different years indicated an increase in the pollution levels in the direction of the new pollution source. The percentage content of sulfur in the 1967 analyses in 1-year needles was between 0.08 and 0.18 in 1969, the values reached 0.25% sulfur in part of the region. Core analyses showed that, since 1962, decreases in ring width of up to 50% had occurred. Thus, the new pollution source has caused a considerable worsening of the forestry fume-damage situation in Aichfeld.
Source: 1

#791
Grill, D., and H. Esterbauer. "Cystein und Glutathion in gesunden und SO_2 geschaedigtea Fichtennadeln." (Cysteine and glutathione in intact and SO_2 damaged spruce needles). Text in German. Eur. J. Forest Pathol., 3(2):65-71 (1973).

Healthy and sulfur dioxide damaged spruce needles were analyzed for water soluble sulfhydryl groups. Total SH content was mainly due to glutathione with some cysteine. Increased cysteine content was only in old needles. Total content of SH groups fluctuates seasonally in the same way in both healthy and damaged needles. Needles damaged from SO_2 always contain more SH groups than healthy needles except immediately after flushing.
Source: 1

#1333
Grill, D., and H. Esterbauer. "Quantitative Bestimmung wasserloeslicher Sulfhydrylverbindungen in gesunden und SO2-geschaedigten Nadeln von Picea abies." (Quantitative determination of water soluble sulfhydryl compounds in healthy and sulfur dioxide-damaged needles of Picea abies). Phyton (Austria), 15(1-2):87-101 (Aug 30, 1973).

The concentration of water soluble sulhydryl groups in extracts of sulfur dioxide-exposed and normal spruce needles was determined colorimetrically and by amperometric titration. The stability of the SH groups in the extracts was also examined. Sulfhydryl components identified were cysteine and gluthathione in proportions of 0-5% and 95-100%. Sulfhydryl contents of SO_2 fumigated spruces were as much as four times SH levels in trees grown in regions with clean air. Sulfite was not identified in either normal or damaged tree needles.
Source: 1

#461
Grill, D., and O. Haertel. "Zellphysiologische und Biochemische Untersuchungen an SO_2 Begasten Fichtennadeln Risistanz und Pufferkapazitat." (Cell physiological and biochemical studies SO_2 fumigated spruce needles. Resistance and buffer capacity). Text in German. (Presented at the International Symposium of Forest Fume Damage Experts, 7th, Essen, West Germany, Sept. 7-11, 1970.) Mitt Forst. Bundesvers., 97:367-386 (1972).

The resistance of spruce needles to sulfur dioxide was investigated by plasmolysis and compared with the buffer capacity of homogenisates. In needles grown in direct light following 24 hours of artificial fumigation, dead cells were found only around the substomatal chambers. Much greater areas of the chlorenchyma were killed in needles grown in shade, following fumigation. The number of damaged cells did not increase as a function of the SO_2 concentrations. Following an initial rise, the alteration remained relatively constant over an SO_2 concentration range of about 1:15. Concentrations above this lead to an abrupt rise in the curve until all cells are killed. Preal-

teration (even by urban air) increases the sensitivity to SO_2. Homogenisates of leaves altered by SO_2 (around pH 4) are less buffered than unaltered ones. In the alkaline range, the altered ones have a greater buffering capacity. Sulfur dioxide resistant needles from a tree grown in an industrial area were essentially similar to noncontaminated ones with respect to buffering capacity. As the needles grow older, their buffer capacity in the acid range is lowered, as is their resistance to SO_2. In older needles, the acid peak of the buffer capacity is suppressed as in altered needles. Thus SO_2 damage is comparable to the results of premature aging. The buffer capacity appears to control the SO_2 resistance of spruce needles, especially under acute fumigation.
Source: 1

#887
Grodzinska, K. "Acidification of tree bark as a measure of air pollution in southern Poland." Bulletin de L'academie Polonaise des Sciences, 19(3): 189-195 (April 1971).

The pH values and buffer capacity were determined for bark samples of 5 deciduous trees (lime, ash, oak, hornbeam, alder) and 1 shrub (hazel) from the air polluted region of Cracow (Southern Poland) and for comparison in the Bialowieza Forest (North-Eastern Poland). A good correlation between acidification of tree bark and air pollution by sulphur dioxide in these areas has been found. The pH values of bark samples ranged from 3.34 to 4.90 and all trees showed the least acidic reaction in the control area (Bialowieza Forest), slightly more acidic in the Niepolomice Forest near Cracow, then around the steel mill (Nowa Hula) and suburbs of Cracow, and the most acidic in the centre of this city. The buffer capacity of the bark also increased with air pollution. Acidification of the tree bark is caused both by local emissions of SO_2 (industry, heating, motor transport) and by significant acidification of rainfalls from Western Europe.
Source: 6

#557
Grosser, K.H. "Beitrage zur Untersuchung des Stammraumklimas und der Luftverschmutzung verschiedener Wald-Bestandestypen in der Umaebung von Berlin." (Investigations into the climate and the air pollution about the trunks of several forest stands in the Berlin area). Arch. Naturschutz Landschaftsforsch, 14(2):117-138 (1974).

Investigations were carried out on forested recreational areas in Berlin relative to differences in temperature during various weather conditions. The dispersion of automobile exhausts from a heavily used road was studied. Results are summarized especially on Pages 127 and 136.
Source: 2

#463
Grosso, J.J., H.A. Menser, G.H. Hodges, and H.H. McKinney. "Effects of air pollutants on Nicotiana cultivars and species used for virus studies." Phytopathology, 61(8):945-950 (August 1971).

Three tobacco cultivars (Nicotiana tabacum) and two Nicotiana species, used for virus identification studies, were tested for susceptibility to ozone, sulfur dioxide, and a mixture of both gases. Nicotiana rustica var. brasilia was the most susceptible cultivar to injury from individual gases, the gas mixture, and ambient polluted air. It displayed from 25-75% leaf injury when exposed to increasing ozone doses (10-30 pphm). Ozone injury to N. glutinoasa fumigated at the same doses ranged from 10-60%. Samsun, Sumsun (NN), and Xanthi cultivars were more resistant to ozone than N. rustica var.brasilia or N. glutinosa. Sulfur dioxide (ca.45 pphm) added to an ozone (ca. 3.0 pphm) atmosphere induced a synergistic response evidenced as injury to all cultivars and species. Mixed gas injury was more acute on N. glutinosa and N. rustica var. brasilia than on Samsun, Samsun (NN), and Xanthi, Samsun and Samsun (NN) were more susceptible to sulfur dioxide (125 pphm) than N. glutinosa and Xanthi. Fumigations produced two injury syndromes: light or dark punctuate flecks on upper leaf surface; or bifacial tissue collapse.
Source: 1

#792
Grouven, H. "Einfluss des Leuchtgases auf die Promenadenund Strassenbaume." (The influence of coal gas on trees on parkways and streets). Translated from German. Belov and Associates, Denver, Colo., 2 p. July 10, 1970. Z. Deut. Landwirthe, 1855:151; Ibid , 1859:360 (July 10, 1970).

Attention is called to the fact that trees on a number of European streets and boulevards have died when grown in soil contaminated by burned oily substances and sulfur and ammonia compounds from adjacent coal gas conduits. This has occurred even where cast iron pipes are used. Another source of vegetation damage is the arsenic and lead contained in dustemissions from foundries.
Source: 1

#464
Grzywacz, A. "Wplyw przemyslowych zanieczyszczen powietrza na grzyby chorotworcze drzew lesnych." (The influence of industrial air pollution on pathological fungi of forest trees). Translated from Polish. Scientific Translation Service, Inc., Santa Barbara, Calif. Sylwan, 15(6):55-62 (1971).

The reaction of pathological fungi to the presence of air pollution is a function of the chemical nature of the pollutants, their concentration, the frequency of diurnal and seasonal changes in concentration, the duration of action, the composition of floras, the degree of damage by phytotoxins in the pollutants, the topography of the terrain, climatic conditions, the character of the forest site, and the sensitivity of the pathogens. The most im-

portant pollutants and their sources are reviewed, including sulfur dioxide. fluorine compounds, smog, and ozone formed from nitrogen oxides. The toxic action of SO_2 with respect to fungi depends on the temperature and relative humidity of the air, increasing with an increase in relative humidity. The occurrence of pathological fungi in forests with polluted air, the effect of air pollution on certain vital processes of fungi, and the mechanism of action of the air pollutants on the fungi are considered.
Source: 1

#333
Guderian, R. "Untersuchungen ueber quantitative beziehungen zwischen dem schwefelgehalt von pflanzen und dem schwefeldioxidgehalt der luft." (The correlation between sulfur content in plants and sulfur dioxide content in the atmosphere). Part 1. Z. Pflanzenkrankh, Pflanzenschultz, 77(4/5): 200-220 (April-May 1970).

Field experiments conducted with monocotyledons, diocotyledons, and conifers in the vicinity of a sulfur dioxide source and gasification experiments conducted in the laboratory to determine the correlation between SO2 emission (concentration and exposure time) and plant sulfur content disclosed that while the absorption of SO2 at high concentrations was relatively small, sulfur accumulation in plants increased with decreasing SO2 concentration and with increasing exposure time. The old assumption that sulfur content in plants was in indication of only chronic SO2 emissions but not of acutely damaging SO2 concentrations was disproved. Under practical conditions, high concentrations do not occur by themselves but always together with low concentrations. In uniform plant material, sulfur accumulation determined by chemical plant analysis is a reliable indicator of SO2 emission levels at which deleterious effects on yield or quality are no longer discernible. In discontinuous exposure to SO2, sulfur accumulation first increases with the number of exposures and their duration and then levels off. Photosynthetic measurements disclosed that the recovery during emission-free periods affected SO2 absorption.
Source: 1

#795
Guderian, R. "Investigation of the quantitative relationship between sulfur in plants and the sulfur dioxide in the air. Part 2. Diurnal variation in sulfur near unaffected and gas-attacked plants." (Untersuchungen ueber quantitative Beziehungen zwischen dem Schwefelgehalt von Pflanzen und dem Schwefeldioxidegegalt der Lüft. Teil 2. Tagesgang in Schwefelgehalt bei unbeeinflussten und begasten Pflanzen). Text in German. Z. Pflanzenkrankh Pflanzenschultz, 77(6):289-308. (June 1970). Part I. Ibid. 77(4-5)(April-May 1970). Part III. Ibid. 77(7) (July 1970).

Fumigation of plants at different hours of the day reveals distinct diurnal changes in sulfur accumulation which exhibits a certain relation to intensity of photosynthesis, but does not coincide with the degree of leaf sensitivity. Apparent photosynthesis and sulfur accumulation reach their maxima in

the late morning hours while leaf injury is most intense in the early morning hours. The decrease in leaf sensitivity during the light period seems to be associated with, among others, the formation of assimilates; further possible causes are discussed.Sulfur is also accumulated during the night hours, which may amount to about one-third of the highest daily values. Sulfur content of unfumigated plants also shows a distinct diurnal variation. These diurnal variations result from changes in dry substance. Level of sulfur accumulation varies considerably with the stage of plante growth. Degree of leaf injury on plants of different age does not show a distinct dependence upon the quantity of accumulated sulfur. Sulfur absorption by leaves of the same age decreased with increasing plant age. Fully developed leaves having the greatest photosynthetic gas exchange also had the greatest sulfur accumulation. Time relationships in the degree of injury of different aged leaves change in respect to each other with level of concentration. Under exposure conditions of low concentration but of sufficient length to result in injury, older leaves are, in general, injured before younger ones. With increasing concentration, effects shift over to the younger leaves until finally, at high concentrations, the degree of injury on just fully developed leaves correlates with sulfur accumulation and apparent photosynthesis. Conifers also show distinct age dependent differences in sulfur dioxide uptake and in the degree of injury. The youngest needles absorb the most sulfur dioxide. Sulfur dioxide absorption and also degree of injury increases with increasing growth of the new shoot, while the preceding year's needles show an inverse tendency. Dissimilar sulfur dioxide exposures may shift the natural relations in sulfur content. Long lived crops show an increase SO_2 content with leaf age while older leaves on short lived plants often have a lower sulfur content than younger ones. Strictly comparable samples have to be taken when proving sulfur dioxide effects with the help of chemical leaf analysis.
Source: 1

#794
Guderian, R. "Untersuchungen ueber quantitative Beziehungen Zwischen dem Schwefelgehalt von Pflanzen und dem Schwefeldioxidgehalt der Luft. Teil 3. Schwefelgehalt geschaedigter und ungeschaedigter Blatteile." (Investigation of the quantitative relationship between sulfur in plants and the sulfur dioxide in the air. Part 3. Sulfur injured and uninjured leaves). Z. Pflanzenkrankh Pflanzenschultz, 77(7):387-399 (July 1970). Part I. Ibid., 77(4-5) (April-May, 1970). Part II. Ibid., 77(6) (June 1970).

The sulfur content of necrotic portions of a leaf and those portions that are still green is determined by the past history of ambient sulfur dioxide concentrations. When an ambient level which causes acute injury is followed by a longer period of no sulfur dioxide or of only insignificant concentrations, then the sulfur content of those parts still functioning may decrease below that of the necrotic portions. In practice, however, sulfur content of the green leaf portions is generally higher. Great differences in the sulfur content of injured and uninjured parts of the leaf probably result from sulfur dioxide effects and, therefore, are a reason why a separate chemical analysis for sulfur may be advantageous. If no separation is made, only leaves having a small proportion of necrosis should be sampled for

(chemical) analysis because these reflect the level of sulfur dioxide pollution better than do severely injured leaves. In addition to the level of sulfur dioxide exposure, sulfur content of plants depends substantially on the duration of pollution-free periods. A single sample taken from vigorously growing, intermittently exposed plants is capable of reflecting only a casual situation. The danger of misinterpretations can be reduced by repeated sampling in the course of the vegetation period. The present results of investigations in both field and fumigation experiments concerning a quantitative relationship between sulfur content in plants and sulfur dioxide content of the air with attention to inner and exterior growth factors, make possible an evaluation of the chemical analysis of the leaf as proof of sulfur dioxide effects. The analysis, along with attention to precisely decribed presuppositions, is a valuable procedure for identifying sulfur dioxide pollution, also in areas with concentrations causing acute injury. The causes for opposing concepts about the diagnostic value of the analysis of plants could be clarified.
Source: 1

#36
Guderian, R. "Einfluss der Naehrstoffversorgung auf die aufnahme von Schwefeldioxid aus der Luft und auf die Pflanzananfaelligkeit." (Effect of nutrient supply on the absorption of sulfur dioxide from the air and on plant susceptibility). Landesanstalt fuer Immission und Bodennutzungsschutz des Landes Nordrhein-West falen, Essen (Germany), 1970 Annual Report, No. 23, p.51-57 (1971).

The effect of various quantities of soil and differing treatments with nitrogen, phosphorus, potassium, and calcium on the susceptibility of plants to sulfur dioxide was studied. The degree of SO2 absorption was determined. Whereas the addition of nitrogen had differing effects on the level of natural sulfur content depending on the type of plant, specific tendencies were noted in the case of other nutrients. The sulfur content of plants increased with an increasing supply of calcium and phosphorus, while it became lower with potassium. Nitrogen fertilization was not uniform in its effect on SO2 absorption from the air. Depending on the soil and type of plant, the sulfur concentration was at times higher and at times lower than in the case of unfertilized plants. In general, nitrogen fertilization increased plant resistance to SO2. A compensated calcium-balance in the soil raised the resistance significantly, with only slight reductions in SO2 absorption. Potassium additions had no effect on SO2 absorption but did increase plant resistance. With increasing phosphorus addition, sulfur concentration and the extent of leaf damage increased.
Source: 8

#793
Guderian, R. "Ergebnisse aus Begasungsexperimenten zur Ermittlung pflanzenschaedigender HF-Konzentrationen." (Findings from gassing experiments for determination of plant - Damaging concentrations). VDI (Ver. Deut. Ingr.) Ber., 164:33-37 (1971).

Extensive experiments have been conducted to determine the effect of hydrofluoric acid gas concentrations on plants. The experimental set-up of minature greenhouses in the form of chambers with walls made of plastic sheet, into which rarefied HF-air mixtures are brought from a generating town via plastic piping mounted below ground. Atmospheric air enters through the roofs of the chambers, drawn in by the suction effect of the piped-in mixture. A change of air thus effected 100 times per hour, and the fluctuations in temperature and humidity inside the chamber follow those of the outer air. The experiments were made with HF concentrations between 0.85 and 25 micrograms/cu m of air. Among the forest cultures, some varieties of fir, spruce, ash, and beech show already after ten days of exposure to average gas concentrations of 1.3 micrograms/cu m of air such distinct damage to needles and leaves that one has to expect drastic retardation of growth in case of exposure for several months or years. The symptoms of damage observed were necrosis on needle tips and blade edges. Fodder plants, particularly varieties of grass and clover, were tested after 16 days exposure to gas of 0.85 and 2.60 micrograms HF/cu m air, respectively. The ensuing enrichment of fluorine in the plants was up to 9 mg F per 100 g dry substance with the weaker HF concentration, and up to 22 mg F per 100 g dry substance with the stronger HF concentration. Visible damage on the clover leaves occurred in the form of chlorosis and in rarer cases necrosis of leaf parts. A table of resistivity of a number o tree, plant, flower, and vegetable varieties to HF effects is shown comprising the very sensitive ones, the sensitive and the less sensitive species. Lasting damage to plants can be caused already by very low HF concentrations in the atmosphere in case of long exposure.
Source: 1

#1334
Guderian, R. "Effects of air pollutants on plants." (Wirkungen von Luftverunreinigungen auf Pflanzen). Text in German. Umwelt, 1972:206-211 (1972).

The effects of air pollutants on plants are described. Air pollutants, such as sulfur dioxide, hydrofluoric acid, hydrochloric acid, peroxyacetyl nitrate, and ozone may cause acute, chronic, and invisible or physiological damages to plants by deteriorating the growth, yield, and quality. The extent of the damage progresses with increasing pollutant concentration, rather than the length of exposure time. Both SO2 and HF interfere with photosynthesis, and the former metabolizes chlorophyll to pheophytin, while HF interferes with porphyrine synthesis. Both SO2 and HF deplete the water reserve of the plant organism. Inert dust is injurious in keeping light away from the leaves and clogging the stomate, while toxic, water-soluble dust components act directly on the exposed parts. Air pollution reduces the resistance of plants to frost and pests. Due to their response to air pollutants, certain plants can be used as bioindicators of air pollution.
Source: 1

#1336
Guderian, R. "Schaeden an Vegetation und Nahrung durch Immissionen aus konventionellen Kraftwerken." (Damages caused by emissions from conventional power plants in vegetation and food). Text in German. (Presented at the Association of German Radiation Protection Physicians and the Association for Radiation and Environmental Research, 12th Conferance, Munich and Nueherberg, West Germany, Oct. 8-9, 1971.) Strachlenschutz Forsch. Prax., 12:81-97 (1973).

Studies and observations on plant damage caused by gaseous and particulate emissions of thermal power plants are surveyed. Dust emissions from obsolete power plants with no adequate filters affect plants in the immediate vicinity by reducing exposure to sunlight and increasing the local temperature on the leaves the dust settles on. While the damaging effect of dust from modern thermal power plants equipped with efficient filters is negligible, such power plants and industries emit considerable amounts of sulfur dioxide and fluorine, the most harmful compounds for plant life. These gases penetrate into the leaves through the stomata. Sulfur dioxide reduces the phytosynthesis, temporarily stimulates dissimilation, and, when present in higher concentration, dehydrates the plant by destroying the osomotic potential, and metabolizes chlorophyll to pheophytin. Intercostal necrosis is caused by SO_2, while apical and edge necrosis is due mostly to fluorine compounds. The plant damage due to SO_2 and fluorine compounds may manifest itself in reduced yield and quality impairment as well as esthetic deterioration. Fluorine, readily accumulating in leaves, is hazardous for animals and humans ingesting flourine-contaminated plant materials. The extent of SO_2 afflicted damage increases progressively with increasing concentration, and cannot be characterized by the product of concentration and exposure time.
Source: 1

#465
Guderian, R., H. van Haut, and H. Stratmann. "Pflanzenschaedigende Fluorwasserstoff-konzentrationen." [Plant damaging hydrogen fluoride concentrations]. Umschau (Frankfurt), 71(21):777 (1971).

Important plants were exposed to defined concentrations of hydrogen fluoride in small greenhouses made of synthetic foil. Spruce, Weymouth pine, Nordmann fir, mountain-ash, and red beech trees showed heavy leaf damage after several days of exposure to concentrations of 1.3 microgram HF/cu m air. After long-term exposure, the growth rate of these species would be retarded Maple, juniper, jew, and cypress were relatively resistant. The black pine showed weak necrosis on the tips of the needles after 10 days of exposure to an average concentration of 4.2 microgram HF/cu m air. At concentrations of 0.85 microgram HR/cu m air, clover and some types of grass stored 8.7 mg HF/100 g dry substance. At only a slightly higher concentration of 1.1 microgram HF/cu m air, up to 28 mg fluorine/100 g dry substance was found. Winter barley showed sure signs of growth retardation after 12 days of exposure to 3.3 microgram HF/cu m air. Oats, yellow sweet lupine, and peas began to show growth retardation at concentrations above 4.0 microgram HF/cu m air. Some tulips, narcissas, hyacinths, and crocusses showed severe injuries after 12 days of exposure to 1.5 and 2.0 microgram of HF/cu m air. Gladioli and begonias showed leaf injuries at concentrations of less than 1.0 microgram HF/cu m air. Chrysanthemums, rhododendrons, snap dragons, lupines, and carnations were considerably more resistant.
Source: 1

#19
Guderian, R., and H. Schoenbeck. "Recent results for recognition and monitoring of air pollutants with the aid of plants." Second International Clean Air Congress, pp. 266-273 (No date).

The reactions of plants may serve for recognizing and monitoring of certain air pollutants. But there are conflicting opinions about the suitability of the sulphur content in plants as an indicator for sulphurous pollution. Author used field and fumigation experiments to determine how sulphur accumulation caused by air pollution under natural conditions can be safely proved. Accumulation shows a distinct diurnal pattern.
Source: 8

#796
Guderian, R., and H. Stratmann. "Freilandversuche zur Ermittlung von Schwefeldioxydwirkungen auf die Vegetation, I. Teil: Uebersicht zur Versuchsmethodik und Versuchsauswertung." (Determination of the effect of sulfur dioxide on plant life by field experiments. Part I. Methodology and evaluation of results). Text in German. Forschungsber, Landes Nordrhein-Westfalen, 1118, 102 p. (1962).

The relationship between atmospheric sulfur dioxide levels and their phytotoxic efforts was studied in five experimental stations and one control station which differed only by their atmospheric SO_2 content on 15 agricultural and horticultural plants, on 4 fruit cultures, 2 fruit-bearing shrubs and 5 silvicultural plants. Sulfur dioxide concentrations were registered continuously by Woesthoff instruments, and their median levels for certain time periods were determined as were the plant reactions at various stages of their development. Acute and chronic damage caused by the various emission levels eas demonstrated in the potato plant, the gooseberry shrub, and the larch tree Young and old leaves of potato plants were much more susceptible tc SO_2 damage than leaves of median age. The SO_2 effect on potatoes was manifested both by a decrease in size as well as in the number of tubers. Leaves of gooseberries manifested intercostal necroses, then fell off; the berry yield was almost nil. Generally the resistance of plants and cultures to SO_2 varied widely not only between species but also between developmental stages and emission levels. The fungicidal effect of SO_2 on plant pests Microsphaera quercins, Taphrina deformans, and Rhizoctonia solani was confirmed. The phytotoxic effects of the inorganic fungicide Cupravit Ob 21 depended on SO_2 emission levels.
Source: 1

#1863
Gusev, M. I. "Dust-retaining properties of leaves of some tree species." In: Survey of U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. Translated from Russian by B. S. Levine. National Bureau of Standards, Washington, D. C., Inst. for Applied Tech., Vol. 3, p. 243-245, (May 1960). CFSTI: TT 60-21475.

A study was made in Tashkent, Russia of the dust-retaining power of leaves of several tree species. Investigations were made in a park where these tree species were growing in close proximity, exposed to the effects of dust from the main city street and from the highway passing through the park. Observations on the dust-retaining power of leaves were made mostly during the summer and fall months. The dust-retaining power of leaves of different tree species varied with the dust concentration in the air. In the summer and fall when rains are scarce a steady accumulation of dust was observed on the surface of the leaves.
Source: 1

#466

Gyoerkoes, T. and J. M. Baretincic. "Determination of F in vegetation with F selective ion electrode." (Presented at the American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting. New York. 7 p.) (Feb. 26 - March 4, 1971).

Preliminary work of the Boyce Thompson Institute was evaluated and some modifications were made. In the modified method, the fluorine is leached out of the ground vegetation using perchloric acid. The sample is then filtered and the filtrate is made up to 100 ml with a buffer containing sodium carbonate, sodium chloride, and sodium citrate. The sample solution should now have a pH of approximately 5.5 and is ready to be read after calibration of the meter with suitable standards. The results of electrode analysis (potentiometry) of 140 vegetation samples with values ranging from 3 to 500 ppm compared to automated analysis shows a correlation of 0.993 and the regression equation indicated a slope of 1 and an intercept of 1.7 ppm. The procedure as modified uses more $HClO_4$ than does the Boyce Thompson method. Also, the application of a wetting agent to both the acid and buffer solutions gives better solution contact with the finely ground sample, yielding a more efficient extraction of fluoride.
Source: 1

#804

Haagen-Smit, A. J., E. F. Darley, M. Zaitlin, H. Hull, and W. Noble. "Investigation on injury to plants from air pollution in the Los Angeles area." Plant Physiol. 27:18-34 (1952).

Spinach, beet, endive, oat, and alfalfa plants were used for the determination of crop damaging pollutants in the air of metropolitan Los Angeles. The air pollution, or smog, symptoms on these indicator plants are well known. The protection of a metalic glaze or silvering on the lower surface of leaves on spinach, beet and endive especially distinguishes this damage from the effect of previously known toxic materials. Activated carbon filters were devised which removed the toxic agents from the polluted air. The filters demonstrated that sublethal concentrations of smog had a depression effect on the growth of the plants. Principal attention was given to the reaction products which are formed in the air from natural components and air pollutants, as well as from the air pollutants with each other, after earlier tests with a series of pure compounds of organic nature failed to produce smog symptoms. The reaction products of ozone with unsaturated hydrocarbons produced typical smog damage on all of the indicator plants. The damaging factor must therefore be attributed to the peroxides formed in the ozonization process. Optimum effects were obtained by using olefins with five and six carbon atoms with the double bond in the end position. However, the end position of the double bond is not essential, since 3-n-heptene, 4-n-nonene and cyclo-hexene gave typical smog damage upon ozonization. The concentration of ozone at which damage occurs with the olefins is well within the range of ozone concentration found in the atmosphere as determined by the rubber cracking test. The optimum activity of the C5 and C6 series is attributed to the stability of the intermediate products in the reaction process. The catalytic oxidation of the olefins with nitrogen dioxide under the influence of sunlight produces oxidation products very similar to those produced by ozone. In the plant fumigations with oxidation products of olefins, lachrymatory effects were often observed. These investigations demonstrate the utility of plants in analyzing air pollutants. They further show for the first time that hydrocarbons, normally harmless air pollutants of organic nature, can cause severe damage through their reaction with substances known to be in the air.
Source: 1

#51

Habjorg, A. "Air pollution and vegetation." Meldinger fra norges Fandbrukshogskole, 52(1):1-23 (1973).

In reply to a request made by the Ostfold Landscape Preservation Association, the Department of Dendrology and Nursery Management programmed an investigation in Sarpsborg which aimed to establish:

1. The effect of SO_2 on the growth and development of vegetation in parks and other planted areas.

2. The ability of vegetation to survive and to adsorb or/and absorb atmospheric pollution and its importance in purifying the air.

This report presents the results of three experiments, a preliminary soil investigation in Sarpsborg and two experiments involving variation of the factors soil type, fertilizer and species, which were carried out in containers in Sarpsborg and at the Agricultural University of Norway.

SO_2 contamination of the air damages vegetation in two ways. Direct damage varies from species to species, but one may generally say that it begins as a scorching of the outer margins of the leaves which gradually become brown and begin to curl. Indirect damage is caused by fluorine in the soil nutrients. During rainfall sulphur dioxide in the air combines with the rain water to form sulphuric acid. This sulphuric acid is neutralized in the soil by an exchange of cations particularly the 8-valent cations, Ca, Mg, Fe, Al, which are then washed out of the soil. In practice it is difficult to distinguish between direct and indirect damage.

The degree of dilution is dependent on the extent of exposure and the concentration of SO_2 in the rain, i. e. the pH of the rain water. Measurement of pH in rainwater and in the soil in Sarpsborg gave values pH 3.3-pH 6.5 in rain water and pH 3.0-pH 6.7 in the soil. The lowest pH values were measured under trees. This seems to support the theory that SO_2 in dry weather accumulates on the leaves and is subsequently washed off by rain. Later experiments supported this fact that plants are capable of purifying the air to a relatively high degree.

After a period of three to four months, containers with soil but without plants in Sarpsborg showed a pH reduction of 0.1 pH units lower than in similar containers at the Agricultural University of Norway. In containers with plants pH were found to be 0.2-0.7 units lower than those at the Agricultural University of Norway. This property of vegetation to adsorb atmospheric pollution is without doubt the most important argument for planting vegetation in industrialized areas. It is possible that the above mentioned relations could be of use in measuring the ability of a single tree species to adsorb or/and absorb atmospheric pollution.

The preliminary soil investigation revealed a positive correlation between the pH and the cation content of the soil, particularly calcium. On an average the phosphorus content as very high. In fertilized areas there were found values for P-AL as high as 133, while some values for unfertilized areas were found to be as low as 2.0. The highest content of soluble phosphorus was at pH 5.1-5.5.

On comparison with plants grown at the Agricultural University of Norway those cultivated in Sarpsborg showed a reduction in growth of 0-95% dependent on the type of soil, species and fertilzier. Experiments showed the Sarpsborg soil to be deficient in calcium, magnesium, potassium and nitrogen. Fertilization of the soil in Sarpsborg with a mixture of iron, manganese, copper and zinc sulphate resulted in a significant growth increase. Addition of the above compounds in optimal quantities reduced the inhibiting effect of deficient soil, which varied from 20-50% of the total inhibition, to 0-10% dependent on the type of soil. Also soil mixtures of peat and powdered basalt required significantly greater additions of calcium and magnesium in Sarpsborg than at the Agricultural University of Norway, while addition of micronutrients inhibited growth in both cases.

The two species used in the experiments showed marked differences in their tolerance of SO_2. In 1969 cultivation in SO_2 exposed soil in Sarpsborg resulted in a growth reduction of 95% for alder (Alnus incana) and 50% for birch (Betula pubescens) while the values in mixed soil were 60% and 0% respectively. In 1970, on addition of micronutrients, reduction in growth was found to be approximately 60% for Alnus incana and approximately 10% for Betula pubescens in SO_2 exposed soil. Corresponding values in mixed soil were approximately 65% and 30%. Thus under all conditions Betula pubescens showed 35-50% greater resistance to atmospheric SO_2 than Alnus incana.
Source: 8

#1337
Habjorg, A. "Luftforurensning og vegetasjon. II. Virkninger av gjodsling og kalking pa vekst og utvikling av 20 lignoseslag dyrket pa sterkt SO_2 eksponert sted i sarpsborg." (Air pollution and vegetation. II. Effects of fertilization on growth and development of twenty woody plants grown in industrial areas). Translated from Norwegian. Meld. Nor. Landbrukshogsk., 52(2):1-14 (1973).

Sulfur dioxide damage and the effects of fertilization were examained for 20 species of woody plants grown in pots of two different soil types, one from an SO_2 exposed area and the other made of a mixture of unfertilized peat and powered basalt. Different amounts of dolomitic limestone and fertilizer were added to the soil, and plants were grown at an SO_2 exposed industrial area and at an agricultural university. Fertilization led to less leaf damage and increased plant growth in all species. Sulfur dioxide damage also varied among species and was manifested either directly as scorching of leaf edges or indirectly through the soil resulting in a slight yellowing of the leaf blades. The experiments resulted in dividing the plants into three groups; SO2-resistant, SO2-intermediate, and SO_2-sensitive. The most sensitive group consisted of Alnus incana, Cytisus purgans, Lonicera morrowii, Pinus silvestris, Rosa Moje, and Sorbus aucuparia.
Source: 1

#1338

Hademenos, Demetrios George. "Production of air ions and ozone by barley tips under electric fields." Syracuse Univ., N.Y., Dept. of Physics, Thesis, (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 137 p. (Jan 1970).

Laboratory study of air ion and ozone production by barley tips under electric fields is described. Both ozone synthesis and air ion formation can be induced by a barley tip, and any plant tip in general, when exposed to an electric field of suffiecient strength as to imitate point discharge. Plants respond physiologically to the ozone and air ions that are formed. The ozone induced inhibiting effects on plant growth; air ions, particular oxygen ions, enhance growth. The rate of ozone formation was highest for seedlings. The relationship between point tip radii and production of ozone, air ions, and current through the specimen as a function of voltage applied between plant tip and positive upper electrode was also studied. Source: 1

#1339

Haedicke, E. "Zur vorselektion auf relative Rauchhaerte bei Laerche mit Hilfe eines morphologischen Merkmals." [On preselection of larches for relative fume hardiness by means of a morphological characteristic]. Nachrbl. Deut. Pflanzenschutzdienst (Berlin), 23(8):173-174 (1969).

In order to cultivate species of conifers that would be more resistant to damage by fumes from industrial waste gases, a speed test on cut branches of European and Japanese larches was developed in Graupa. Branches with curled needles were more hardy with regard to fume effects than branches with straight needles, both for ungrafted and grafted plants. Two illustrations show the appearance of the characteristic needles. Mean damage percentages were compiled in a table, thus offering an external characteristic for a preselection of more fume resistant trees of the above mentioned species. Source: 1

#1340

Haertel, O. "Oekophysiologie und anthropogene Umweltveraenderungen." (Ecophysiology and anthropogenic environmental changes). Translated from German. (Presented at the Botanists Convention, Innsbruck, Austria, Aug. 31, 1971) Ber.Deut.Bos.Ges., 84(9):497-506 (1971).

The effects of human influences on the environment and these results are discussed. Effects on the environment which are becoming more perceptible are the results of two circumstances: concentration in preferred living areas; and the capability of Man to satisfy his civilizing demands in steadily increasing measure, according to his technical capabilities. Encroachments on the environment are direct and indirect: direct through producing the necessary dwelling, cultural, and civil areas; and indirect through water products, and especially through those of the technological civilization Man has produced. The greater demand for soil. removal of vegetation

the use of fertilizers and insecticides, and the depletion of soil nutrients in relation to unbalancing the original state are considered. Harmful pollutants stemming from industry and the increased use of motor vehicles, including sulfur dioxide and fluorine compounds are reviewed. Photoxidation products such as ozone, the main components of smog, carbon dioxide and their effects on plants are also reviewed.
Source: 1

#281
Hagen, L. J. and N. P. Woodruff. "Particulate loads caused by wind erosion in the Great Plains." (Presented at Air Pollution Control Association, Annual Meeting, 66th, Chicago, Ill., June 24-28, 1973, Paper 73-102.) Preprint, Air Pollution Control Assoc., Pittsburgh, PA., 24 p. (1973).

Previous research related dust concentrations to visibility and showed that the median dust storm concentration was 4.85 mg/cu m and the average duration was 6.6 hr. Wind speed and particulate concentration profiles were integrated to computer dust passage at various locations in the Great Plains. The annual dust passage varied widely, depending upon precipitation, but it averaged 40,000 tons per vertical sq mile in the 1950s and 12,600 tons in the 1960s. Changes in the dust passage between adjacent locations were consistent, and the lowest dust passage occurred in the least erosive areas. The estimated total particulates suspended in dust storms ranged from 37 to 551 million tons annually; the average dropped from 244 million tons in the 1950s to 77 million tons in the 1960s. Estimates of suspended particulates agreed well with dust deposition data collected for a limited period in the 1960s. Based on these estimates, wind erosion produces a larger mass of particulates than do all other primary sources in the United States combined. Further, the concentrations and frequent occurrence of dust storms make it doubtful that any Great Plains state can meet all the criteria in the National Ambient Air Quality Standards, particularly if particle size continues to be disregarded in the standards.
Source: 1

#1081
Hagevik, George (ed.) The Relationship of Land Use and Transportation Planning to Air Quality Management. New Brunswick, University Extension Division, Rutgers University (May 1972).

The papers in this volume are a timely addition to the literature on air quality management. There clearly are no ready answers presented in these pages. In fact, what we have done is just defined the issues involved, more clearly. Even though there is a recognition that we are faced with intransigent problems for which we have weak public policy tools, this recognition in and of itself is encouraging since it is a necessary precondition for effective action. To my mind the next decade will be a most exciting one in our battle for cleaner air.
Source: 8

#399

Haghiri, F. "Absorption and uptake of cadmium by plants." Ohio Rep., 68(3): 72-74 (May-June 1973).

A series of greenhouse experiments were conducted to determine cadmium absorption by plants via foliar and root systems and its translocation into the seed, vegetative growth, and Cd concentration of crops as influenced by soil applied Cd, and the relative uptake of Cd by various vegetative crops. The effect of soil applied Cd at varying rates on the dry matter yield and Cd concentration of soybean and wheat tops is shown. In both crops, as the level of applied Cd increased, the Cd concentration of plant tops increased and yield increased. At the lowest level of soil applied cadmium, 2.5 ppm, the toxicity of Cd in both soybeans and wheat began to cause a marked decrease in the total dry matter produced. The concentration of Cd in the vegetable crops studied varied considerably depending on the plant series. Highest Cd concentration was found in lettuce while, the lowest concentrations occurred in green pepper and radish roots. The toxic level of Cd for humans is 3 mg.
Source: 1

#1341

Haisman, D. R. "The effect of sulphur dioxide on oxidising enzyme systems in plant tissues." J. Sci. Food Agr., 25(7):803-810 (July 1974).

The effect of sulfur dioxide enzyme systems in plant tissues is discussed. Sulfite dips ranging in concentration from 600 to 1300 ppm of SO_2 can control discoloration in peeled potatoes. Higher concentration induce other undesirable quality changes such as flabbiness and exudation. The minimum concentration of SO_2 required to prevent discoloration varies with the source and variety of the raw material, according to the level of enzyme activity and the nature of the phenolic substrates. In both apples and pears, treatment with SO2 can lead to undesirable softening of the tissue during storage. It is not known if this is through reaction with another enzymic system or by direct chemical attack. The effect of SO_2 on texture is worse at low pH values.
Source: 1

#467

Hajduk, Juraj. "Verlaengerungs wachstum der Keimlinge als biologischer test von durch Fluorexhalate intoxizierten Boeden." (Extension growth in seedlings as a biological test of soils contaminated with fluorine exhalates). Biologia, 24(10):728-737 (1969).

Biological tests based on measurements of pea and barley seedling root extension growth to evaluate the toxicity of fluroine exhalates from an aluminum plant were carried out. The aluminum plant is located in the Hron River Valley and exposed to northwest and north winds with a hilly background on its southern side; the location is characterized by 30% still days/year. Soil located varying distances from the emission source and control soil

treated with known amounts of dust from the fusion electrolysis shop of the factory were used for the seedling growth experiments. Lowest growth rates of pea seedling roots appeared on the soil exposed to the highest amounts of fluorine contamination as affected by meteorological and topographic interactions. Inhibition of pea seedling root growth was well correlated with the amounts of fluorine contaminated dusts aided to the control soils. Pea seedlings can be utilized as a biological testing species for the evaluation of fluorine contamination of soils exposed to this pollutant. Barley seedlings elicited irregular reactions and, thus, were rejected as unsuitable for similar tests.
Source: 1

#194
Halbwachs, G. "Der Wasserhaushalt rauchgeschaedigter Holzgewaechse." (Water distribution in smoke-damaged woody plants). Translated from German. Translation Consultants, Inc., Arlington, Va., 6 p. Allgem. Forstztg., 78:196-197 (1967).

Since withering symptoms appearing in smoke-damaged spruce and pine are similar to the effects of extreme drought, osmotic coefficients for needles of healthy and smoke-damaged pine stands were determined and the suction capacities in various crown sections were established. Osmotic coefficients were measured by cryoscopy, investigation of unaffected needles in the field showed that the osmotic coefficients were higher at the extremities than in the basal parts. With smoke damaged needles, necrosis of the extremities eliminates those parts of the tissue at which the highest osmotic values are found, which must necessarily result in an impaired water distribution. Measurements made in normal pine and spruce stands revealed that the suction capacity in a tree increases with increasing height of the branches. However, similar studies of severely damaged samples showed not only changes in absolute suction values but also a greatly deviating distribution of these values at various heights. Smoke emissions primarily affect conifer needles which subsequently are no longer capable of producing the suction force necessary for assuring the water supply beyond a level exceeding a certain height.
Source: 1

#1343
Halbwachs, G. "Untersuchungen ueber den Wasserhaushalt Rauchgeschaedigter Forstgehoelze." (The water balance in forest trees damaged by pollution). Text in German. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynaradowcj Konf. Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p. 209-218 (Sept. 9-14, 1968).

Regardless of the effect of the site, steadily increasing continuous sap pressure is operative from the stem upward to the tip of the crown in undamaged spruce, pine, and birch trees, while in identical damaged species a distinct decline in sap pressure can be observed in the apical region of the trees. This decline in sap pressure is not necessarily a function of the insertion height of the branch under examination, but rather of the degree of damage to needles or leaves. Red pines in particular showed a close correlation between sap pressure decline and the extent of damage decaying needles. This phenomenon can probably be explained physiologically by the destruction of a comparatively small number of apical needles with the highest osmotic pressure, causing a decline in sap pressure.
Source: 1

#1344

Halbwachs, G. "Zur Aufklarung der Schadigungen von Pflanzen durch Teerdampfe." (For the clarification of tar vapor damage to plants). Translated from German. Data Methods Corp., Denver, Colo., 6 p., Oct. 12, 1970. Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 167-172 1969.

To answer the question which compounds of tar vapors damage plants, and especially potatoes, several of the pure components of tar were tested. Since only vapors evolving between 100 and 300 C cause injuries, the experiments were restricted to acenapthene, acridine, anthracene, carbazole, chrysene, fluoranthene, fluorene, napthalene and phenanthrene. Because evaporation of solvents results in small crystals on the epidermis, these substances were mixed with glycerine forming very small droplets on the surface of the leaves. Injuries occurred only with acridine, anthracene and fluoranthene, but solely when the plants were put in direct sunlight after the fumigation. These three compounds have a very similar chemical constitution in showing a condensed three ring system in one plane. Other acene and anthracene derivatives such as phenazine, xanthene, 2-methyl-anthracene, 9-methylanthracene and 9-10 dihydroanthracene, were also examined. During microscopic observation of the droplets, it was found that droplet changes in regard to a fluorescent reaction resulted under the influence of ultraviolet light.
Source: 1

#1342

Halbwachs,G. "Physiologische Probleme der Vegetationsschaedigung durch gasforemige Immissionen." (Physiological problems of vegetation damage by gaseous immissions). Translated from German. Leo Kanner Assoc., Redwood City, Calif. 15 p., Nov. 1972. Ber Deut. Bot. Ges., 84(9):507-514 (1971).

The relationship between fume emissions and the water economy of plants was investigated. Since the apertures are the points of entry of noxious gases, all factors influencing the closing movements of the stomata are important. The condition of openness of the stomata depends on the water economy of the plant, and thus on the environmental factors of water supply, light, temperature, and atmospheric humidity. Test were conducted -- gasing with sulfur dioxide and hydrochloric acid ranging from subliminal to toxic concentrations -- to determine the reactions of the stomata to noxious gases. Curves were plotted for damaged and undamaged spruce trees studied in the tests. Values for suction stress in different weather conditions are reviewed.
Source: 1

#985

Hales, J. M., M. A. Wolf, and M. T. Dana. "A linear model for predicting the washout of pollutant gases from industrial plumes." AIChE Journal, 19(2): 292-297 (March 1973).

A simplified method for predicting the washout of gaseous constituents from industrial plumes has been developed. This method is a linearized version of a more general treatment given previously. It is based upon an application of conventional mass-transfer theory in conjunction with existing plume dispersion models and accounts for reversibility of the adsorption process and liquid-phase mass-transfer resistance. The method presented in this paper is sufficiently simple to permit hand calculation, if necessary.

This model is recommended for calculation of washout of gases from plumes under conditions where the gas exhibits physical or pseudophysical absorption behavior. It is expected to apply with reasonable accuracy for gases with linear solubility relationships; accuracy for situations involving other gases is expected to be less satisfactory, depending upon the degree of deviation from this idealized behavior.
Source: 5

#1345
Hall, M.A. and L. Ordin. "Subcellular location of phosphoglucomutase and UDP glucose pyrophosphorylase in Avena coleptiles." Physiol. Plantarum, 20: 624-633 (1967).

The subcellular distribution of UDP glucose pyrophosphorylase and phosphoglucomutase extracted from oat coleoptiles was investigated to determine the effects and mode of action of ozone and peroxyacetyl nitrate (PAN) upon the enzymes in the constituent fractions. The inhibition of phosphoglucomutase by PAN was confirmed and the enzyme in the subcellular particulate fractions was more inhibited than that in the soluble fraction. The UDP glucose pyrophosphorylase was not inhibited by peroxyacetyl nitrate or O_3 in vivo but was inhibited by PAN in vitro.
Source: 1

#468
Hammett, F. S. "Studies in the biology of metals, III. the localization of lead within the cell of the growing root." Protoplasma, 5:135-141 (1928).

A variety of tests on root tips of onion sets, white beans, and field corn proved definitely that lead is concentrated within the nucleus and walls of these cells. Roots which had been grown in distilled water containing 10 to the minus 4th power concentrations of lead nitrate were used as experimental material. Sulfuric acid and sodium bicarbonate were used to precipitate lead sulfate and lead carbonate in cell walls. Sodium sulfide was used to precipitate lead sulfide in the nucleus. The nucleolus of corn appeared to have a selective affinity for lead combination not found in the other roots.
Source: 1

#1349
Hampp, R., and W. Hoell. "Radial and axial gradients of lead concentration in bark and xylem of hardwoods." Arch. Environ. Contam. Toxicol., 2(2): 143-151 (May 1974).

The bark and wood tissues of the hardwood trees Robinia pseudoacacia L., Tilia cordata Mill., and Acer platanoides L., grown in different localities of Munich with varying traffic intensity, were quantitatively analyzed for lead content in both radial and axial directions. In comparison to the non-heart-wood forming genera (Tilia, Acer), the heartwood-forming Robinia showed distinct differences in radial distribution of lead - the sapwood of

Robinia had higher lead concentrations than the heartwood. The innermost heartwood zone of this species had a higher lead content than did the younger heartwood tissue. In Tilia and Acer, the wood zones of different ages did not exhibit significant differences in their lead concentrations. The bark surface showed a high lead concentration which could be washed off to a large extent with water. The lead concentration in the trunk of Robinia increased in the basipetal direction. The lead content in the bark and sapwood of this species was proportional to the traffic intensity in the neighborhood. The results are discussed in relation to the possible translocation of lead within the trees.
Source: 1

#1347
Hampp, R., and K. Lendzian. "Effect of lead ions on chlorophyll synthesis." Naturwissenschaften (Berlin), 61(5):218-219 (1974).

Seeds of Avena sativa L. were grown in the dark in wet vermiculite at 22 C. When the seedlings were 16 days old the primary leaf was cut into pieces 1 cm long and 0.5 g of these leaf pieces were put in 25-milliliter Erlenmeyer flasks in 10 ml glycylglycine with and without lead chloride and preincubated in the dark for 1 hr. The flasks were held for 72 hr at 21 C in a water bath, illuminated at 7000 lux, and shaken 40 times a minute. Chlorophyll was extracted in 80% acetone and the content of chlorophyll a and chlorophyll b determined as per Ziegler and Egle. Synthesis of both types of chlorophyll was reduced in proportion to the increasing amounts of lead ions. Even concentrations as low as 50 micromoles PbCl2 had a statistically significant effect. At lower concentrations (0-500 micromoles), synthesis of chlorophyll b was inhibited to a greater extent than that of chlorophyll a; at higher concentrations the ratio of chlorophyll a to chlorophyll b was balanced.
Source: 1

#1348
Hampp, R., and H. Ziegler. "Anreicherung von Blei in Scheliesszellen." (Enrichment of lead in stomata). Text in German Naturwissenschaften (Berlin), 61(7):326-327 (1974).

Leaves of spinach (Spinacia oleracea L.) were placed with their stems immersed in a 5mM solution of lead nitrate at constant external conditions (22 C, 41% relative humidity, 2300 lux). The lead distribution in the epidermis cells and in the stomata was studied with an X-ray microprobe. A significant enrichment of lead in the stomata was observed. The lead accumulation in the epidermis cells was small but measurable.
Source: 1

#1346
Hampp, R., H. Ziegler, and I. Ziegler. "Die Wirkung von Bleiionen auf die 14CO2-Fixierung und die ATP-Bildung von Spinatchloroplasten." (The effect of lead-ions on the 14CO2-Fixation and on the ATP-synthesis by spinach). Biochem. Physiol. Pflanzen, 164(2):126-134 (1973).

Relatively little is known about the mechanism of lead effects on plants. The element lead is not known to have a function in the metabolism of plants and animals. With the increasing pollution of plants by automobile exhausts, knowledge of this gains importance. For this reason chloroplasts of spinach leaves were isolated. For fixation of carbon (14) dioxide the isolated chloroplasts were placed into a solution in a flask. The flask was in a water bath with a temperature of 20 C. After 3 min of preliminary illumination, carbonic acid ions and 0.1 ml of a lead nitrate sollution were added. After 6 min of illumination, the reaction was stopped with 3 ml 80% methanol. The photosynthatic 14C02 fixation by isolated spinach chloroplasts was inhibited by lead (++) non-competitively. The increase in inhibitory actions was most pronounced at 5-10 micromoles (Pb(++) concentrations. Even at high concentrations (200 micromoles Pb(++), about 15% of the 14C02 fixation capacity was left. The inhibitory action of Pb(++) was not reduced by calcium(++). Lead did not change the fixation pattern fundamentally, only the formation of sugar-diphophates was more strongly reduced than that of the other compounds. The ATP formation in irradiated chloroplasts was drastically reduced; the increase of inhibitory action was most pronounced at concentrations up to 20 micromoles.
Source: 1

#986
Hanawalt, R.B. "Environmental factors influencing the sorption of atmospheric ammonia by soils." Soil Sci. Soc. Amer. Proc., 33:231-234 (1969).

Under conditions of controlled temperature and atmospheric ammonia concentration, the sorption rate for atmospheric ammonia by 6 soils from New Jersey decreased only slightly over exposure periods up to 4 days and averaged 55 to 74 kg of NH_3-N/ha/year. The ammonia sorption rate for these soils increased rapidly with increasing ammonia concentration and moderately with increasing temperature. Calculated energies of activation suggest that sorbed ammonia is held by chemical bonds rather than by physical adsorption. Increasing the velocity of gas flow across the soil surface brings more ammonia into contact with the soil and thus enhances the sorption rate. Soils sorb significant amounts of ammonia from the atmosphere which under some environmental conditions may constitute a major mechanism in the transfer of nitrogen from the atmosphere to soils.
Source: 5

#1279
Hanawalt, R. B. "Soil properties affecting the sorption of atmospheric ammonia." (Presented at the Western Society of Soil Science, Los Angeles, June 1967.) Soil Sci. Soc. Am. Proc., 33(5).725-729 (Sept.-Oct. 1969).

The influence of several soil factors on the rate of sorption of atmospheric ammonia was evaluated. The contribution of both atmopsheric and soil factors in governing the overall sorption process was placed in the proper perspective. At controlled atmospheric-level ammonia concentrations, ammonia sorp-

tion from the atmosphere was weakly correlated with increasing cation exchange capacity and percent clay. Alteration of organic matter content and soil acidity produced only slight changes in sorption rates. These data indicate that lack of bonding sites per se does not limit the sorption rate. In air dry soil, the major portion of the sorption occurs in the uppermost 0.5 cm. Sorption rates were closely related to increasing air permeability and moisture content. Since atmospheric ammonia concentrations, air velocity across the soil surface, and temperature also strongly influence sorption rates, it is concluded that sorption of atmospheric ammonia by soils is primarily governed by those factors which effect the rate of supply of ammonia to the soil surface and the fraction of the ammonia molecules which are actually captured.
Source: 1

#195
Haneda, Mikiko and Fumio Tsunoda. "Fukkabutsu ni yoru taiki osen chosa no tame no shihyo shokubutsu ni tsuite." (Indicator plant in fluoride air pollution investigation). Nippon Koshu Eisei Zasshi (Japan. J. Public Health), 19(9): 449-456 (Sept 1972).

Atmospheric fluoride accumulates in the leaves of some plant species, thus designating them as a fluoride air pollution index. Irises, gladioli, and pines as pollution indicators were tested around an aluminum factory. A very high concentration of fluorine was determined in the upper part of the iris leaf and was in proportion to the actual fluoride air pollution index. A fluroine content of 30-50 ppm (dry weight basis) or 10-20 ppm (wet weight basis) indicated that the air was polluted by fluorides. Similar results were determined for the gladioli and pines.
Source: 1

#266
Hankin, L. "Lead poisoning - A disease of our time." J. Milk Food Technol., 35(2):86-97 (Feb. 1972).

The lead poisoning problem among children is examined in detail with respect to the biochemical aspects, sources of lead contamination, body burden of lead, testing, and treatment. The outward signs of lead poisoning range from listlessness and abdominal pain to vomiting, to mental retardation. The sources of lead contamination include air pollution, i.e., lead emissions attributed primarily to automobile exhaust fumes; natural emissions of silicate dusts, volcanic halogen aerosols, forest fire smoke, aerosol sea salts, and meteoritic smoke; food contaminated by lead fallout on crops and pasture, accidental uptake by animals, and uptake by plants from soil and from effluents used in irrigation materials; growing crops contaminated by automotive exhausts; dust fallout from mining operations, and sewage sludge application to soils; water poisoned by natural contamination, fallout from auto and industrial pollution, and lead piping; containers containing lead in their makeup; soils; and paints containing lead and ingested by children. Some laboratory criteria for the diagnosis of lead poisoning are lead content in blood, x-rays of gastrointestinal tracts or bones, elevated urine level, basophilic stippling of red blood cells and determination of delta-aminolevulinic acid in uring. Once diagnosed, the victims of lead poisoning may be treated by chelation therapy.
Source: 1

#270
Hanover, J. W. "Factors affecting the release of volatile chemicals by forest trees." (Presented at the International Symposium of Forest Fume Damage Experts, Essen, West Germany, September 7-11, 1970). Mitt. Forst. Bundesvers., 97:625-644 (1972).

The factors that regulate or affect the quality and quantity of volatile chemicals released by trees are indirectly related to such problems as photosynthetic efficiency, insect attraction, human allergies, air pollution damage to trees, draught or cold resistance, and species density and diversity; these factors are given theoretical consideration. The principle volatiles release by trees are terpene compounds. Their release is genetically controlled and is modified by many nongenetic factors. Data are presented which show the methods and results of gas chromatographic analyses of liquid and vapor samples from numerous tree species. The leaf surfaces of various tree species have also been examined using the scanning electron probe microscope to determine the structure and amounts of waxes present in and around the stomates.
Source: 1

#119
Hansbrough, J.R. "Air quality and forestry." In: Agriculture and the Quality of Our Environment, N.C. Bradley (ed.). AAAS Publication #85, Washington, D.C., pp.45-55 (1967).

A brief discussion of inquiries to forests from air pollution and the contribution of forests to air pollution. Also, how woody plants may alleviate the problem of air pollution. Cites a few examples from the literature. Ties together much of the research and makes recommendations on areas which need further work.
Source: 7

#196
Hansen, E.D., H.H. Wiebe and W. Thorne. "Air pollution with relation to agronomic crops: VII. Fluorides uptake from soils." Agron. J., 50: 565-568 (1958).

Five soils varying in such characteristics as pH, lime, clay, organic matter, and soluble salts, were treated with sodium fluoride at the rate of 0, 200, 400, 800, and 1600 ppm of fluorine. Turnips and alfalfa were grown, harvested, and analyzed for fluorine. Similar experiments were conducted using treatments with sodium fluorosilicate instead of sodium fluoride. Plant yields were generally reduced when the fluoride content of the tissues exceeded 60 ppm on a dry weight basis. Reduction of fluoride uptake was associated with increased content of lime, clay, and organic matter in the soils studied. In general, the fluoride was absorbed less readily from sodium fluorosilicate than from sodium fluroide, and reductions in yield were also less with the fluorosilicate. Fluorine uptake from soils which were exposed to several years of airborne fluorine contamination was not appreciably higher than fluorine uptake from several soils taken from an area of little or no contamination.
Source: 1

#798
Hanson, George P. "Man and air -- Threats to prairie survival." Lasea Leaves, 20(4):78-81,92 (Dec 1970).

Most pollutants enter the leaf through tiny pores in the leaf surfaces and cause internal leaf damage. These tiny pores or stomates are the passages through which gas exchanges take place during photosynthesis and respiration. At a given pollutant level, other things being equal, a plant growing under conditions of high humidity will take in more pollutant and become more severely damaged than a plant growing under arid conditions. Once the pollutants have entered the leaf, each has its own characteristic type of interaction with the plant tissues. Small animals living along a busy highway could accumulate lead by consuming lead-containing herbage or breathing lead laden air. Fluoride air pollutants damaging to plants are hydrogen fluoride and silicon tetrafluoride. The characteristic symptom of fluoride damage is necrosis on leaf tips and margins where the fluoride has been concentrated. Ethylene causes a general reduction in growth, decreases apical dominance, and stimulates lateral development. Ozone enters through the stomates and attacks the palisade tissue, while sulfur dioxide enters the leaf through the stomates and reacts with water on the moist cell surfaces to form sulfite which is in turn slowly oxidized to sulfate. Peroxyacetyl nitrate enters the leaf through the stomates where it attacks the cells of the spongy mesophyll, and nitrogen dioxide causes growth reduction and defoliation at concentrations often present in polluted areas. Air pollution is having a detrimental economic effect on agriculture in the nation, while also altering the ecological relationships of plants and animals. Fortunately, most species have a great wealth of genetic variation in sensitivity to air pollution. The mechanism of plant tolerance to air pollutants is mentioned.
Source: 1

#1350
Hanson, G.P. "Relative air pollution sensitivity of some Los Angeles arboretum plants." Lasca Leaves, 22(4):86-89 (Dec. 1972).

Factors are identified which may lend tolerance in plants from the few studies which have investigated the mechanism of air pollution tolerance in plants. These include small stomate size, low stomatal frequency, ability to close stomacats upon contact with air pollutants, high concentrations of carbohydrates, free amino acids, ascorbic acid in leaf tissue, increased fatty acids in cell membranes, defective root system, and slow growth rate. Many of the proposed air pollution tolerance mechanisms would be detrimental to a plant competing with other plants in a pollution-free environment, and the plant would probably lose out in the single survival. The ponderosa pines which have evolved as the dominant vegetation in many forested areas are suddenly finding themselves at a severe disadvantage by their inability to cope with a drastically altered air composition. The cedars and giant sequoias previously handicapped because of the genetic restraints upon their growth and development now find themselves better able to compete in the polluted air.
Source: 1

#23
Hanson, G. P., and L. Thorne. "A partial pollution solution: plant trees!" Firl, 19: 35-36 (June 1970).

Recent studies at the L. A. State and County Arboretum show that plant leaves have the capacity to trap significant amounts of smog. Smog resistant plants absorb less than sensitive plants, but extremely sensitive plants will be quickly killed and will cease functioning as a smog trap. Used petunia to test absorptive powers. Also tested Bougainvillea. Found that ozone-resistant plants have ozone-sensitive guard cells which close stomata to prevent leaf damage. At low ozone levels, though, stomata remain open and ozone is trapped. Authors propose planting smog tolerant vegetation.
Source: 8

#398
Hanson, G. P., and L. Thorne. "Vegetation to reduce air pollution." Lasca Leaves, 22(3):60-65 (September 1972).

Several plant and tree species were tested for ozone tolerance and sensitivity levels to determine the absorption potential of these species for pollutants. Pollutant uptake was measured in units of diffusion resistance. The greater sensitivity of the plant to ozone injury, the greater the efficiency for pollution absorption and the lower the diffusion resistance. Mechanisms of physiological tolerance to ozone included extreme ozone sensitivity of guard cell; a higher fatty acid content; and a higher ascorbic acid content. Based on theoretical calculations, a belt of 20,000 trees well spaced from one another would absorb an estimated 90 lbs of ozone daily.
Source: 1, 6

#797
Hanson, G. P., L. Thorne, and C. D. Jativa. "Ozone tolerance of petunia leaves as related to their ascorbic acid concentration." Preprint. Los Angeles State and County Arboretum, Arcadia, Calif., 28 p. (1970).

The relationship of ozone tolerance to ascrobic acid content in the leaves of petunias was investigated. The leaves of two tolerant and two sensitive petunia varieties were grouped according to size, age, and position. Within all varieties, the higher the ascorbic acid content, the higher the ozone tolerance. Correlations between ascorbic acid concentration and surface area and leaf thickness were made. Genetic sutdies indicated that leaf thickness may be unrelated to ozone tolerance. Cross-breeds of the sensitive and insensitive plants at different physiological ages suggest that leaves of a given size increase in ascorbic acid content as the plant becomes more mature and begins to flower. The possibility that ascorbic acid may be involved in ozone tolerance in other species, namely tobacco and pine, is discussed.
Source: 1

#1335
Harger, J.R.E. "Damage to vegetation by chlorine gas." Int. J. Environ. Studies, 1:93-108 (1972).

Chlorine gas released accidentally from a Chlor-Alkali plant (mercury cell process) resulted in extensive damage to vegetation downwind of the factory situation at the head of Howe Sound in British Columbia. Within 1 mi downwind of the plant, most species comprising the emergent vegetation in the area experienced between 30 and 90% foliage damage. Individual species demonstrated differing sensitivity as did individual organisms. Damage indicative of the presence of chlorine gas was detected up to 11 mi downwind from the release point. The destruction of foliage decreased with distance from the spill sight. Three 4-month-old rabbits, housed outside 1 mi north of the plant died 4 days after the spill.
Source: 1

#558
Harvard, M., and M. Treshow. "Impact of ozone on the growth and reproduction of understorey plants in the aspen zone of western U. S. A." Environ. Conserv., 2(1):17-23 (Spring 1975).

The purpose of this study was to learn how ozone might affect the growth and reproduction of understorey species of the aspen community, and thereby influence its stability and composition. Plants of 14 species belonging to the aspen community were grown in greenhouse chambers and fumigated with ozone for three hours each day, five days per week, throughout their growing seasons. The plants were exposed to 30 pphm (parts of ozone per hundred million parts of air), 15 pphm, ambient air reaching 5-7 pphm during about 2 hours each day, and filtered air.

Exposure to ambient air did not appear to cause a significant reduction of total plant weight in any of the species investigated, while plant weight of Achillea millefolium and Isatis tinctoria grown under such conditions was significantly greater than that of control plants grown in filtered air. At 15 pphm, growth of Isatis tinctoria, Madia glomerata, and Viola italica, was significantly reduced; on the other hand, growth of Ligusticum porteri and Polygonum aviculare was increased. At 30 pphm, growth was substantially suppressed in all plants except Chenopodium album and Phacelia heterophylla.

Six species produced fruits and seeds. At 15 pphm, seed production by Madia glomerata and Polygonum douglasii was significantly reduced. At 30 pphm, seed production was also reduced in Polygonum aviculare and Lepidium virginicum.

The most significant conclusions to emerge from this study were (1) the sensitivity of several species to relatively low ozone concentrations, and (2) that this sensitivity varied sufficiently to make major shifts in community composition probable following only a year or two of exposure. The significance of such shifts would depend on which species were being replaced, the resource value of the remaining resistant species, and the impact on community stability of any such changes.
Source: 2

#397
Harvey, D.M., and C.L. Hedley. "Multichannel system for the study of net carbon dioxide photoassimilation by leaves." Lab. Pract., 23(10):567-568 (Oct. 1974).

A multichannel system for the study of net carbon dioxide photoassimilation by leaves is described. The central feature of the system is a water-cooled 35 cm diameter radially symmetrical assimilation chamber which includes two 6 mm (internal diameter) gas ports, one leaf temperature probe, and a recess for a plasticine-embedded leaf petiole. Net CO_2 exchange is estimated with a multichannel infrared gas analyzer. The light source for the system is a water-cooled 6000 watt xenon arc lamp mounted in a central position 240 cm from the assimilation chamber floor. Leaf temperature is monitored with transistor-diode thermometer probes, with the sensor being placed in contact with the leaf underside. A known concentration of CO_2 is continuously generated by a cuvette gas supply, with the relative humidity of the gas supply being predetermined by a temperature-regulated humidifier. The system has thus far been satisfactory for investigation of the effects of plant temperature and illumination history on subsequent net CO_2 uptake by dicotyledonous leaves and for comparison of the relative efficiency of CO_2 uptake by different genotypes.
Source: 1

#571
Harward, Max R. and Michael Treshow. "The impact of ozone on understory plants of the aspen zone." Air Pollution Control Association, Annual Meeting, 64th, Atlantic City, N.J. 71-98 (June 27-July 2, 1971).

A study was undertaken to learn how ozone might affect growth and reproduction of understory species of the plant community, and thereby influence its stability and competition. Plants of 15 representative species of the aspen community were grown in chambers and fumigated four hours per day, five days per week throughout their growing season. Plants were exposed to 30 pphm, 15 pphm, ambient air reaching five to seven pphm for two hours per day, and filtered air. The study was repeated for three seasons. Several species were more sensitive to ozone than might have been suspected. Also, this sensitivity varied sufficiently that major shifts in community composition would be probable following only a year or two of exposure. More tolerant species have no doubt already become dominant over more sensitive species in natural plant communities exposed to elevated ozone concentrations.
Source: 1

#1351
Hasegawa, T., Y. Yamada, M. Yoshida, and H. Yoshikawa. "Shokubutsuchu no iobun no sokutei. Dai-1-po." (Determination of sulfur contents in plants, Part I). Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, Taiki Osen Kenkyu(J. Japan Soc. Air Pollution), 5(1):37 (1970).

Sulfur in pine leaves was analyzed by means of combustion in a high-frequency furance and by coulometry. The sample was mixed with alumina powder and electrolyzed iron powder in a crucible and was combusted in a high-frequency oven

with oxygen flow of 1 l/min. When the amount of alumina was over 1.2 g for 1.0 g of iron, fusion was incomplete; when alumina was less than 1.0 g, rapid combustion was observed. When alumina was fixed at 0.6, at least 0.6 g of iron was necessary for complete fusion. Since pine leaves contain carbon, chlorine, nitrogen, and phosphorus in addition to sulfur, those elements were also analyzed. Analytic data for sulfur and chlorine (the samples were taken from pines growing on the sea shore) are tabulated according to soluble S, insoluble S, soluble and insoluble S together, Cl, and total S (affected by amount of Cl).
Source: 1

#197
Hasegawa, Toshio, Yoshiaki Yamazaki, Hideo Hayashi, and Masaaki Takahashi. "Fukkabutsu ni yoru taiki osen chosa. Dai-3-po." (On the atmospheric fluoride pollution. Part III.). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):225 (1970).

The effects of hydrogen fluoride and sulfur dioxide emitted from a hydrofluoric acid plant in Suita, Osaka Prefecture, were investigated. Samples of the surrounding atmosphere, agricultural crops (rice plants), and soil were analyzed for fluorine and sulfuric acid ions. In addition, the wind speed and wind velocity were measured. Fluorine was analyzed by the alizarine complex method, and sulfuric acid ions by the barium chromate method. The fluorine content of rice plants was 340-379 ppm for those badly damaged, 200-210 ppm for those mildly damaged, and 42-76 ppm for those not damaged at all. The concentrations also tended to decrease with distance from the factory. In soil, the fluorine concentration was 12-38 ppm, and there was not much difference between the polluted and the control areas. The concentration of fluorine at the emission source, measured by dry-type cylindrical filter methods showed 86.2 mg of fluorine/400 sq cm/100 hr. The meteorological data showed that there is a relationship between the frequency of wind direction and the concentration of the pollutants downwind from the emission source.
Source: 1

#334
Hasegawa, T., and H. Yoshikawa. "Fukkabutsu ni yoru taiki osen chosa (1)." (On the atmospheric fluoride pollution. Part I.). Text in Japanese. (Proceedings of the 10th Annual Meeting of the Japan Society of Air Pollution, 1969.) Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):147 (1969). Part II. Ibid., 4(1):148 (1969).

Fluorine compounds emitted from chemical fertilizer, ceramics, and chemical industries were suspected to be the cause of death of 70 oxen for agricultural use between 1953 and 1964 in the outskirts of Osaka. Fluoride analysis was conducted on the urine of Japanese oxen in the area in order to determine the extent to which fluorides in air enter grass and feed. Fluoride content was found to be as high as 20 ppm. Further investigation was performed in order to determine the relationship between the fluorine compound content in the bones of the dead oxen and dust fall, plants, animal feed, and soil characteristics. A substantial amount of fluorides was discovered in the bones, and it became apparent, that the compounds originated from the factories. It was not obvious whether they were the direct cause of death, because some inorganic fluorine compounds do not lead to death even at high concentrations. Since the oxen were also used for ploughing the fields, conclusions could not be drawn as to the real effects of the fluorides on the animals.
Source: 1

#335

Hasek, R. F., H. A. James, and R. H. Sciaroni. "Ethylene -- its effect on flower crops." Florist's Rev., 144(3722):16-17, 53-56 (April 3, 1969).

Selected references are drawn upon to give a concise background of the ethylene problem as it relates to floriculture. Sources of the gas are mentioned, along with possible solutions at various industrial levels. Also, ethylene can be given off by the plants themselves. Fungi can be a source of ethylene, as well as the natural decay of organic matter, especially under the confined conditions of florist's refrigerators. The area around greenhouses must be kept clean at all times, and disease organisms, insects, and other sources which could cause ethylene damage to cut flowers and potted plants must be controlled. Growers must continue to press plant breeders for more ethylene tolerant varieties so that the susceptible ones can be phased out. Better economical exhaust control devices for automobiles and trucks must be sought.
Source: 1

#198

Haupt, R., and G. Flemming. "Sozialhygienische Probleme bei der Gestaltung von Erholungswaeldern." (Problems of social hygiene in the planning of recreational forests). Wissen. Z. Tech. Univ., (Dresden), 22(4):688-692 (1973).

Photoactinal, thermal, and hydrometeorological properties of forests are outlined, and the qualities of noise abatement and dust retention are discussed. Forests provide only a very weak and only in exceptional cases an efficient protection against gaseous pollutants because the quantity of gaseous pollutants (particularly of sulfur dioxide) exceeds far the adsorption capacity of trees. The protection against dust is far better. At dust sources close to the ground level (automobiles) the forests reduce the spread of dust particles and thus diminish the ground level emission area. With higher elevated dust sources, the dust falls on the tree crowns. As a consequence, the interior of a forest and a several 100 m broad zone on the leeward side of the edge of the forest are protected against dust. Trees with hairy, secretive leaves as well as those with rough leaves, retain more dust than those with smooth leaves. The filtering effect of smooth leaves, however, recovers faster. Dense closed forest edges are desirable with large dust adsorbing surfaces. The species planted on forest edges should be smoke resistant because particulate emissions are usually accompanied by gaseous pollutants. Juniper, oak, arbor vitae, privet as well as nearly all other deciduous trees are rather smoke resistant.
Source: 1

#1882

Haut, Van Hans. "Die Analyse von Schwefeldioxydwirkungen auf Pflanzen in Laboratorium sversuch." (Determination of the effect of sulfur dioxide on plants through laboratory experiments). Staub, (Duesseldorf) 21(2):52-56 (Feb, 1961).

Pot plants (radishes, rye, maple, oat, beans, pine) were exposed to various concentrations of sulfur dioxide for varying periods of time. Reactions of the plant during the various stages of development, as well as the influence of various environmental conditions, were observed in separate experiments with a constant SO2/air mixture. The degree of injury was found to increase with the increase of the SO2 concentration. For example, exposure to 3 mg SO2 cu m air caused necrotic symptoms on only 2% of the leaf surface, while 12 mg SO2 damaged 77% of the leaf surface. The functional dependence of damage or the effect of concentration and exposure time can be expressed by an expoential function. Short-term high concentrations are more damaging than long-term low concentrations. Most plants displayed greater resistance at night than during the day. The damaging effect of successive concentration peaks decreases with increasing length of pollutant-free intervals. While exposure to concentration peaks in intervals of 5 min damaged 50% of a leaf, exposure in intervals of two hours damaged only 5%. In many plants the lowest resistance to pollutants was observed shortly before blossoming. Plants well nourished with nitrogen were found to be more resistant. Faded leaves due to low moisture in the soil were injured less than well-watered plants.
Source: 1

#470

Haut, H. van. "Wirkungen von Luftverunreinigungen auf Pflanzen." (The action of air pollutants on plants). Text in German. In: Ullmanns Encyklopaedie der Technischen Chemie, Vol. 2/2, 3rd ed., Berlin, Urban and Schwarzenberg, p. 349-356 (1968).

Sulfur dioxide and hydrogen fluoride are the main industrial pollutants causing widespread damage to plants; nitrogen oxides, ammonia, hydrogen sulfide, chlorine or hydrochloric acid, bromine, and iodine produce effects limited to the industrial area. Hydrophyle mineral acid vapors such as sulfuric or nitric acid exhibit their action within the area close to the emission source. Depending on the concentration of pollutants and on the duration of their action, plant damage can be acute, chronic, or latent. Acute damage is produced by high air pollutant concentration following short-time exposure; leaf necrosis, general weakening of plant vitality, reduced growth, and sometimes plant death are its main effects. Chronic plant damage occurs in areas exposed to long lasting low pollutant concentrations and includes chloroplast damage associated with inhibition of photosynthesis and overall impairment of metabolism. Latent damage is considered a precursor of chronic damage. Alterations of the structure, pH, and nutritional quality of soil from the cumulative action of pollutants cause indirect damage to plants. Diagnosis of plant damage from air pollutants can be made visually, by chemical analysis of air and plant samples, and by biological tests. Experimental evaluation of pollutant action on plants in special exposure chambers or in the free field should constitute one of the basic tools of research in this field. Included are descriptions of such experimental facilities are described and prevention of plant damage from pollutants by special soil treatments is discussed.
Source: 1

#472

Haut, Hans van. "Nachweis mehrer Luftverunreinigungskomponenten mit Hilfe von Blaetterkohl (Brassica oleracea acephala als Indikatorpflanze)." Analysis of several air pollution components with kale (Brassica oleracea acephala) as indicator plant). Staub, Reinhaltung Luft, 32(3):109-111 (March 1972).

Kale (brassica oleracea acephalia) was used for identification of fluorine, chlorine, sulfur, and lead air pollutants. The plants were exposed to the atmosphere at various sites in the Ruhr valley. Plastic boxes with 60 l volume were used for growing the plants. The fluorine concentration was determined by the electronic method developed by Reusmann and Westphalen, the chloride concentration by the familiar method of potentiometric titration, and the sulfur concentration by the microanalytic method by Stratmann. The lead concentration was determined by inverse-polarographically. For the determination of these components by the mentioned methods only 5 g dry substance are needed. The plants, five in a pot, were exposed over several successive years from the beginning of August to the middle of November. Control plants were exposed outside the Ruhr valley in an entirely emission-free area. The F-level in the plants was in all cases above (with one exception) that of the control plants. It ranged from 4.1 to 20.1 mg/100 g dry substance. In washed leaves, the F concentrations were lower by 15 to 30%. The chloride concentration in the plants from the polluted area was four times the concentration in the control plants, the lead concentration was ten times the concentration in the control plants. The highest sulfur dioxide was 1.83% versus 1.33% in the control plants. The results show that kale serves well as an indicator for the mentioned pollutants, as well as for a number of polycyclic hydrocarbons, including the carcinogenic benzo(a)-pyrene.
Source: 1

#469

Haut, H. van and H. Stratmann. "Experiments Untersuchungen ueber die Wirkung von Schwefeldioxyd auf die Vegetation." (Experimental studies on the effects of sulfur dioxide upon vegetation). Forschungsber. Landes Nordrhein-Westfalen, 884:1-63 (1960).

Plants were exposed to sulfur dioxide concentrations in air chambers in order to determine the effects of the following parameters upon the causation of damage: concentration and exposure time, stage of development, climatic factors, and nutritional factors. These effects are considered for agricultural plants, flowers, deciduous trees, and conifers. Results from the environmental chamber studies cannot be applied directly to field conditions, but they provide important reference information for the determination of tolerance times in field experiments and thus for the evaluation of an emission level with regard to the danger to vegetation which it encounters.
Source: 1

#517
Haut, Van H., and H. Stratmann. "Experimentelle Untersuchungen ueber die Wirkung von Stickstoffdioxid auf Pflanzen." (Experimental study of the effect of nitrogen dioxide on plants). Text in German. Landesanstalt fuer Immissions und Bodennutzungsschutz des Landes Nordrhein-Westfalen, Essen (West Germany), Rept. 7, p.50-70 (1967).

The effect of nitrogen dioxide on plants was measured in climatic chambers and compared with that of sulfur dioxide. The leaf damage caused by NO_2 and NO was largely identical with the damage caused by sulfur dioxide both in its effect on color and by the pattern of the damage. In dicotyledons, the gas damages intercostal fields and leaf rims; in monocotyledons, leaf damage takes on the form of yellow and white necroses, conifers manifest uniformly red and brown coloring. The slight differences manifested in NO_2 and SO_2 damage do not permit to differentiate between the two gases. Whether chemical lead analysis can be used to determine damage caused by NO_2 is as yet unresolved. The grouping of plant species by their degree of resistance to NO_2 is largely identical with that to SO_2. The sensitivity of plants to NO_2 is the same during the day as at night while the same plants are more resistant to SO_2 at night than during the day. The resistance of plants to NO_2 varies considerably with their growth period and the age of leaves is decisive for the degree of and type of damage incurred. The damage threshold for annual plants is approximately 0.8 mg NO_2/cu m air.
Source: 1

#471
Haut, H. van, and H. Stratmann. "Farbtafelatlas ueber Schwefeldioxid-Wirkungen an Pflanzen." (Color plate atlas of the effects of sulfur dioxide on plants). Essen, West German, Verlag W. Girardet, 206 p., 1970.

Based on the observations of vegetation in the vicinity of a pollution source, an iron ore roasting plant, results of field experiments, and controlled fumigation studies, text and plates were compiled to illustrate the effects of sulfur dioxide on plants. The response of specific organs of plants to exposure, different kinds of plant damage, and patterns correlated to type and age of plant, duration and strength of exposure, effects of light, temperature, and humidity, and seasonal and diurnal changes are reviewed. The interaction of environmental factors (such as soil, nutrition, and fertilization) and genetics on plant response and the effects of the damages on plant appearance, crop yield, root crops, and plant composition were illustrated. Crops, flowers, fruits, orchards, forests, trees, and vegetables were studied. Plant damage included necrosis, stippling, chlorosis, and leaf damage.
Source: 1

#366
Hawksworth, D.L. and F. Rose. "Qualitative scale for estimating sulfur dioxide air pollution in England and Wales using epiphytic lichens." Nature, 227: 145-148 (1970).

The sulfur dioxide in the air can be estimated qualitatively by studying the lichens growing on trees. A ten-point scale has been constructed and used in pilot surveys in England and Wales, southeast England, and the city of Leisester. See text for explanation of points.
Source: 7

#800

Hawksworth, D. L., F. Rose, and B.J. Coppins. "Changes in the lichen flora of England and Wales attributable to pollution of the air by sulphur dioxide." In: Air Pollution and Lichens. B. W. Ferry, M.S. Baddeley, and D.L. Hawksworth (eds.), Toronto Univ. Press, Toronto , Chapt. 16, p. 330-367 (1973).

Changes in the lichen flora of England and Wales which are attributable to air pollution are described. Increases in mean levels of sulfur dioxide in the air havehad an extremely deleterious effect on the lichen vegetation of England and Wales. Local differences in meteorological factors which occur in urban areas can be ignored, but any general climatic trends must be considered. Meteorological changes which occurred between 1800 and 1970 produced improved conditions for lichen growth, but the lichen vegetation in those areas of England which have mean winter SO_2 levels below 30 micrograms/cu m remained almost unchanged. Since 1958 there has been a decline in emissions of SO_2 from commercial, domestic, and industrial sources, but a correspondingly large increase in the emissions from power stations.
Source: 1

#1352

Hayakawa, K., and T. Kubo. "Taiki osen no kankyo yoryo ni kansuru kisoteki kankyu Sono (1)Kankyo shihyo to shite no shokubutsu katsuryoku." (Fundamental studies of air pollution effects on environmental capacity. (1) Plant vitality as an environmental index). Text in Japanese. (Presented at the Japan Society of Architecture, Tokyo, Hokuriku District, Scientific Lectures, Japan, Oct. 1-3 1974, Paper 4085.) Preprint, Japan Society of Architecture, Tokyo, p. 169-170 (1974).

Correlations between plant health and environmental pollution were investigated in the Tokyo area. Seven types of trees (deciduous and evergreen) were selected in 19 locations, such as parks, where trees grow in abundance. Vitality of five to 10 trees of each type at each location was checked with respect to 12 items of observation, rated from 1 (good) to 4 (bad). When the rations were plotted on a map of the Tokyo area, lowering the arboreal vitality was discernable along a more or less northsouth line, worsening in an easterly direction. This distribution agrees for the most part with the atmospheric pollution concentration distribution of metropolitan Tokyo, and indicates the feasibility of using plant indicators to measure the environmental index of atmospheric pollution.
Source: 1

#1354

Haywood, J.K. "Injury to vegetation and animal life by smelter wastes." Dept. of Agriculture, Washington, D. C., Bureau of Chemistry, Bull. 113 (Rev.) 63 p. (July 7, 1910).

The injurious effects which wastes from sulfur-bearing copper ore smelting operations have on animal and plant life are considered. Sulfur contained in the ore is given off as sulfur dioxide and sulfur trioxide. Arsenic, which is often present in the ore, is given off in fumes which settle out and deposit on the crops surrounding the smelter. Waste water containing copper can percolate through the ground and reach streams. Particulates discharged through the stack settle out, causing injury to plant life. Mechanisms of damage to plants are discussed, and thresholds for SO_2 are given. Results of field investigations to determine the extent of damage to plants are reported. Trees, corn, wheat, and other plants are injured to varying degrees. Studies of the arsenic content of crops and soils prove that cattle deaths are attributable to arsenic poisoning. Methods of analysis used on plants, soils, water and ores are described.
Source: 1

#374
Heagle, A.S. "Effect of low level ozone fumigations on crown rust of oats." Phytopathology 60:252-253 (1970).

Exposure of crown rust differential varieties of Avena spp. to 10 pphm ozone for 6 hr. in the light for 10 days after infection with Puccinia coronata significantly reduced the growth of uredia. Urediospores produced on the plants exposed to ozone germinated as well, produced as many appressoria, and resulted in as much infection as spores produced on unexposed leaves. Exposure on dry leaves to 20 pphm ozone for 3 hr for 1-5 days did not affect urediospore germination, appressoria formation, or penetration.
Source: 7

#373
Heagle, A.S., and L. W. Key. "Effect of ozone on the wheat stem rust fungus." Phytopathology, 63:397-400 (1973).

The effects of low concentrations of ozone on various phases of the uredial cycle of the wheat stem rust fungus were studied. Daily 6-hr ozone exposures of infected plants significantly decreased the growth of hyphae and the number of urediospheres produced. The mean spore production over a 17-day period was 90, 82, and 50% of the controls when plants were exposed for 6 hr/day for 17 days to 6, 12, and 18 pphm ozone, respectively. Ozone exposures 24 to 48 hr before inoculation injured the plants and reduced penetration and infection. When plants were inoculated immediately after exposure and before injury developed, no reduction in penetration and infection occurred. Germination and infection of wheat plants by spores produced on exposed plants was not affected when these spores were used to inoculate plants not previously exposed.
Source: 7

#372
Heagle, A.S., and L.W. Key. "Effect of Puccinia graminis f. sp. tritici on ozone injury in wheat." Phytopathology, 63:609-613 (1973).

Significantly less ozone injury occurred in mesophyll cells in the substomatal areas of wheat leaves inoculated with urediospores of Puccinia graminis f. sp. tritici than in noninoculated leaves. The protective effect was present in inoculated areas when plants were exposed to ozone 2, 3, or 4 hr after the start of urediosphere incubation. The mesophyll cells under stomata with appressoria attached were rarely injured. Mesophyll cells under stomata without appressoria attached were also protected in areas of the leaf that were inoculated. Noninoculated areas were not protected. These results suggest that a diffusible substance is produced by germinating spores and infection structures that results in protection of localized areas of wheat leaf tissue from ozone injury.
Source: 7

#371
Heagle, A.S. & A. Strigland. "Reaction of Erysiphe graminis f. sp. hordei to low levels of ozone." Phytopathology 62:1144-1148 (1972).

Barley, Hordeum vulgare, and powdery mildew, Erysiphe graminis f. sp. hordei, were exposed to ozone at concentrations that often occur in polluted ambient air. The effect of ozone on germination of conidia, on plant infection by conidia, on growth of mycelia, and on sporulation were determined. When sporulating colonies were exposed to ozone, the percentage infection by exposed conidia was significantly reduced. Ozone exposures during spore incubation also significantly reduced infection. Germination of conidia was not significantly reduced by the same exposures which inhibited infection. Colony and spore mass length was significantly increased by ozone exposures which caused chlorosis of barley leaves.
Source: 7

#1355
Heaney, R.J., J.R. Fletcher, and A.W. Huffaker. "Evaluation of sulfur dioxide injury to economic crops." (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo., June 14-18, 1970, Paper 70-131.) Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 21 p. (1970).

When the Utah Copper Division of Kennecott Copper Corporation purchased a copper smelter from the American Smelting and Refining Company, it organized the Agricultural and Meteorological Research Department to monitor the atmospheric concentrations of sulfur dioxide and other pollutants, as well as to evaluate any damage to vegetation that could be attributed to the smelter operations. One of the prime responsibilities of the new organization was to maintain good commununications with the farmers in the area and continue the policy of crop damage payments that has been established by the American Smelting and Refining Company. Background information is given on the development of the injury payment program and its scientific basis. Evaluation of SO_2 injury to vegetation is carried out by using a diagonal sampling pattern across a given field and taking a ten-stem sample at regular intervals to make a total sample which will be representative of the whole field. Ten representative stems are selected from the sample having SO_2 injury, and a total leaflet count is made on these ten stems. The estimated percent of leaflet area injured is reported on one hundred leaflets and the average is reported. Total injury is calculated by multiplication of the three reported percentages; the percentage of stems with SO_2 injury, leaflets having injury, and the amount of leaflet area injured. These data are applied to the total yield of the crop obtained from available records or estimate taken at the time of harvest. Statistical analysis of the injury data has been utilized to develop a regression equation for calculating economic crop loss as a function of marked stems or product of marked stems and marked leaflets. Data are also presented on the total annual economic value paid out for crop injury and the effect of emission controls in the reduction of economic loss by crop owners.
Source: 1

#1356
Heath, R.L., P. Chimiklis, and P. Frederick. "The role of potassium and lipids in ozone injury to plant membranes." In: Air Pollution Related to Plant Growth. American Chemical Society Symposium Series, Environmental Protection Agency Grant 801311, 29 p. (1974).

The role of potassium and lipids in ozone injury to plant membranes was investigated. Changes in plants which are immediately noted can usually be related to loss of water from the leaf, as a necrosis or a dessication induced collapse of the palisade layers. Acute injury results in closure of the stomates which prevents O_3 penetration and further water loss. Potassium plays a dominant role in maintaining a favorable plant cell water status and the deleterious effects of O_3 occur primarily due to disruption of the normal ionic balance. The mechanism of O_3 damage consists of O_3 attach of a sulfyhydryl group or a fatty acid residue; permeability changes of the membrane leading to loss of K ion and loss of osmotic water; inhibition or loss of K ion pump activity for the reacquisition of lost K the loss of a critical level of ion, and gross disruption of cellular metabolism.
Source: 1

#26
Heck, W. W. "Discussion of a paper by E. A. Schuch and J. K. Locke entitled 'relationship of automotive lead particulates to certain consumer crops'." 6 pp. (1968). (No publisher).

Author rejects Schuck and Locke contention that contamination is a reason for high lead values in plants. Author cites lack of analytic and testing procedures to justify Schuck and Locke contention. Claims S&L ignored heavy lead contamination from lead arsenate insecticides but concentrated instead on effects of airborne Pb. Although author considers the study of oranges the best designed, he disputes S&L theory that Pb contamination of orange meat results when oranges are peeled and suggests that it could be from translocation from root absorption.
Source: 8

#1929
Heck, W.W. "The role and activities of the Agricultural Branch of the National Air Pollution Control Administration." (Presented at the Impact of Air Pollution on Vegetation Conference, Toronto, Ontario, April 7-9, 1970.) Preprint, Air Pollution Control Assoc., Toronto, Ontario Section, Air Pollution Control Assoc., Pittsburgh, Pa., TR-7 Agricultural Committee and Ontario Dept. of Energy and Resources Management, Toronto, Air Management Branch, 6 p. (1970).

The Agricultural Branch of the National Air Pollution Control Administration has a dual role in serving both the Department of Agriculture and the Department of Health, Education, and Welfare. The Branch was started in 1956 and has three main objectives: the maintenance of liaison between the two departments on agricultural aspects of air pollution; the carry-

ing out of research studies on the effects of air pollutants on vegetation; and the provision of consultative services to all levels of government, to industry, and to others desiring technical advice on the agricultural effects of air pollution. In the past decade, the activities of the branch increased greatly as many reorganizations occurred in the two departments. The educational role of the branch has expanded with an increasing number of states requesting training programs for their personnel in the detection and assessment of air pollution injury to vegetation. The research studies on air pollution effects on vegetation provide data for the formulation of air quality criteria and standards, and aid in the estimate of the economic impact of air pollution on agriculture.
Source: 1

#1859
Heck, W.W., O.C. Taylor, and H.E. Heggestad. "Air pollution research needs for herbaceous and ornamental plants and for agriculturally generated pollutants." (Presented at the Air Pollution Control Association, Annual Meeting, 65th, Miami Beach, Fla., June 18-22, 1972, Paper 72-154.) Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 34 p. (1972).

The effects of various air pollutants on economically important crops and ornamentals have been studied since before the turn of the century. Summaries of this effects research in Criteria Documents, developed by the Environmental Protection Agency should be reviewed in light of differential regional sensitivity. These differences are associated with environmental parameters and the distribution of pollutants. Many research efforts on air pollution injury to vegetation have been poorly coordinated, leaving many knowledge gaps. A better assessment of the air pollution impact on vegetation is required to prompt realistic controls for pollutants affecting agriculture. Research areas of major concern include: baseline information on effects of pollutants on agricultural productivity; dose response information to support predictive mathematical models for acutte and chronic studies of growth, yield, and quality effects; effects of pollutants interacting with other pollutants and with insects and plant diseases; mechanisms of pollutant action; genetic changes related to pollutant effects; effects of environmental stresses on plant response to pollutants; evaluation of plants, including soil microbes, as pollution sinks; development of techniques to minimize pollutant effects; and the effects of agricultural chemicals as air pollutants. There is a need for studies that consider the whole plant in its natural environment. Conceptual models, interrelating pollutant effects and their interactions, and, ultimately, mathematical models will be needed to develop an intelligent approach to land management.
Source: 1

#89
Heggestad, H. E. "Reciprocal effects of plants and pollutants." American Nurseryman, 13:92-102 (November 1972).

A review article describing visible injury to plants by a variety of air pollutants and varied rates of pollutant uptake by plants. Initial uptake rate of NO_2 by alfalfa and oats $\propto$ concentration in the range of 0-24 pphm. Uptake of radioactive SO_2 by alfalfa was $\propto$ concentration at low concentrations. Alfalfa removed the following gaseous pollutants in decreasing amounts: HF, SO_2, Cl_2, NO_2, O_3, PAN, NO. Spruce trees most sensitive to injury by SO_2 removed more of the gas than resistant trees.
Source: 6

#1357
Heck, Walter W. "Air pollution and the future of agricultural production." Advan. Chem. Ser., 122:118-129 (1973).

The relationship between air pollution and future agricultural production is examined in terms of the difficulty of assessing the consequences of pollution, predicting economic loss to vegetation, and identifying the pollutants responsible for plant damage. The most widespread and pervasive pollutants affecting agricultural production include ozone, sulfur dioxide, other oxidants, fluoride, and ethylene; trace elements present in exhaust gases, pesticides, and gases such as ammonia and chlorine are also suspected as being a threat to plant life. No method is available for predicting the economic loss to vegetation from air pollutants, and surveys to date have not found a way to incorporate the impact of pollutants on the growth and yield of crops where visible injury is not recognized. The impact of pollutants on plant communities in terms of species composition, frequency, presence, total biomass, or quality of product after long term exposures appears to be an area of ultimate concern where future research should be directed. Tobacco is an example of a single crop agricultural community on which the effects of ozone have long been recognized. Community studies must be approached from an effects modeling standpoint if any long term understanding of air pollution effects on ecosystems is to be attained. A look at the future indicates that agronomic and other cultivated species would be acutely impaired if tomorrow s oxidant and sulfur dioxide levels remain as they are today, although the potential effect of an increase in such pollutants is difficult to forecast.
Source: 1

#199
Heck, W.W. , M. E. Bloodworth, W. J. Clark, D.R. Darling, and W. Hoover. "Environmental pollution by missile propellants." Texas Agricultural and Mechanical Research Foundation, College Station. (Rept. No. AMRL-TDR-63-75.) 89 p. (August 1963).

Experimental procedures were developed to study the effects of hydrazine, unsymmetrical dimethylhydrazine (UDMH), pyridine borane, and nitronium perchlorate on plant growth and development, soil structure, and aquatic organisms. Plant growth and development research included: seed germination, seed growth, and treatment of plants in water culture, by sprays, and with the test chemicals as air pollutants. Under the conditions used in this study, the four chemicals do not appear to be important environmental contaminants in relation to plant growth and development. Both UDMH and hydrazine are strongly adsorbed or decomposed on clay particles. Montmorillonite and kaolinite clays, as well as the test soils, seem to accelerate the decomposition of the UDMH and hydrazine. Pyridine borane was adsorbed on the test soils but apparently

was not adsorbed on the pure clays. The aquatic life was very sensitive to the three organic compounds and to some extent to the perchlorate ion.
Source: 1

#1490
Heck, W. W., J. H. Dunning, and I. J. Hindawi. "Interactions of environmental factors on the sensitivity of plants to air pollution." J. Air. Pollution Cont. Assoc., 15:511-515 (1965).

Before potential damage to vegetation can be adequately forecast, even after an air pollution alert has been placed in effect, a clear understanding of the interactions of environment on plant sensitivity must be ascertained. This involves detailed study of single factors and then multiple factors using the phytotoxicants in question. Factors studied or suggested include light (quality, intensity, and duration), temperature, carbon dioxide concentration, humidity, wind, soil moisture, soil aeration, nutrient levels, and soil texture. This paper presents a review of the work relating plant injury to specific air pollutants as conditioned by several environmental conditions supported by research on the interactions of ozone with these environmental conditions.
Source: 5

#539
Heck, W.W., O.C. Taylor and H.E. Heggestad. "Air pollution research needs: Herbaceous and ornamental plants and agriculturally generated pollutants." J. Air Pollut. Control Assoc., 23(4):257-266 (April 1973).

Aspects of various air pollutants on economically important crops and ornamentals have been studied since before the turn of the century. Summaries of this research on the effects of air pollutants, that have appeared in criteria documents developed by the Environmental Protection Agency, should be reviewed with respect to differences in plant susceptibility found in various sections of the country. These susceptibility differences are associated with variations in both environmental conditions and distribution of pollutants. Research experts on air pollution injury to vegetation have often been poorly coordinated resulting in many gaps in our knowledge. A better assessment of the impact of air pollution on vegetation is required to attain realistic controls for pollutants affecting agriculture. Research areas of major concern include: baseline interaction on effects of pollutants on agricultural productivity; dose-response interaction to support predictive mathematical models for acute and chronic studies on growth yield, and quality effects; effects of pollutants interacting with other pollutants and with insects and plant diseases; mechanisms of pollutant action; climatic changes related to pollutant effects; effects of environmental stresses on response to pollutants; evaluation of plants including soil microbes as pollutant sinks; development of techniques to minimise pollutant effects; and the effect of agricultural chemicals as air pollutants. There is a need for studies that consider the whole plant in its natural environment. Conceptual models interrelating pollutant effects and their interactions and ultimately mathematical models will be needed to develop an intelligent approach to land management. Effects of agriculturally produced pollutants on plants and other receptors will be identified and quantified.
Source: 2

#801
Heck, W.W. and D.T. Tingey. "Ozone; Time-concentration model to predict acute foliar injury." Environmental Protection Agency, Raleigh, N.C., Air Pollution Control Office, 23 p. (1971).

An understanding of the response of plant species to specific doses of an air pollutant or a group of pollutants is essential before air quality standards can be established in areas under crop production. An experimental design was developed utilizing five periods from 0.5 to seven hours with two ozone concentrations at each time period. Concentrations were chosen that would produce threshold and severe injury at the time periods in question. From these data for each species, an equation was developed utilizing concentration as the dependent variable, and both foliar injury and time as independent variables. The model allows for the development of a three-dimensional response surface within the limits of the times and concentrations used. The model should be of practical importance in predicting the concentration of ozone that will produce a given amount of injury to a specific crop during a single 12-hr day. Research to date suggests the model may be used for other pollutants and for other plant species that show injury following exposure to high ambient ozone concentrations.
Source: 1

#200
Heggestad, H. E. "How plants fight man-made pollution." Sci. Teach., 39(4), 4 p. (April 1972).

Various investigations concerning the response of plants to polluted environments are reviewed. Removal of ozone by plants is regulated by the same factors that control the exchange of water vapor between the leaves and the atmosphere. Depending on the species, ozone concentration, and other factors, uptake of ozone by leaves often results in acute injury, premature aging, and plant senescence. Sulfur absorption by plants is least when the concentrations of sulfur dioxide are highest. Sulfur accumulation may occur even under pollution conditions which do not depress plant yield or the quality of plant products. The initial uptake rate of nitrogen dioxide by alfalfa and oats is directly proportional to concentration in the range of 0 to 24 pphm.Alfalfa removes gaseous pollutants in the following order: hydrogen fluoride most rapidly, followed by sulfur dioxide, chlorine, nitrogen dioxide, ozone, peroxyacyl nitrate, and nitric oxide. The absorption rate of nitric oxide is very low, and it is not possible to detect any absorption of carbon monoxide. There is a close relationship between the uptake of these pollutants by plants and their solubility in water. The action of various woody plants on SO_2 removal is described. Soil organisms, including fungi, yeast, and bacteria, also play an important role in air purification, especially for gases such as CO and ethylene, which are not absorbed by green plants. Soil also acts as an effective sink for SO_2 and NO_2. Trees, shrubs, and tall grass make effective sound barriers and thus reduce noise pollution. Removal of particulates by plants has little, if any, effect on the vegetation itself, but plant removal of gaseous pollutants, such as ozone, PAN, sulfur dioxide, and chlorine, may cause injury to plants.
Source: 1, 6

#1362
Heggestad, H. E., C. E. Anderson and W. A. Feder. "Determining acceptable limits for air pollution dosages and vegetation effects: ozone." (Presented at the Air Pollution Control Association Annual Meeting, 67th, Denver, Colo., June 9-13, 1974, Paper 74-224.) Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 32 p., 1974.

Acceptable limits for air pollution dosages and vegetation effects of ozone are presented. Assessment from current publications is based on effects of single exposures to low (ambient) concentrations of ozone on several plant species, results of several successive exposures to ozone or ambient oxidants, and the effects of exposures to pollutant mixtures. Exposure to 5 pphm ozone for a few hours a day for several days will produce injury and reduce growth of many plants, especially when they are grown and exposed at high humidity. The primary standard of 8 pphm for 1 hr will probably cause little or no reduction in yield or productivity of most plant species. This concentration may be tolerated longer in arid areas than in humid areas. Separate studies for specific crops in different regions of the U. S. will be needed to determine the total dose of ozone that specific plants can tolerate without significant effects on productivity. Mixed gases can show coergistic effects. However, until there is more evidence of increased damage due to mixture of ozone and other gases under natural conditions, no adjustment in acceptable limits of ozone because of the possibility of mixed gases seems warranted. When ozone in ambient air is high, the concentrations of some other pollutants affecting plants, such as acid gases and ethylene, tend to be low.
Source: 1

#1360
Heggestad, H.E., and E.F. Darley. "Plants as indicators of the air pollutants ozone and PAN." Council of Europe, Committee of Experts on Air Pollution, Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 329-335 (April 22-27, 1968).

Plants are useful indicators of the presence of photochemical air pollutants. Young pinto bean plants are suggested to determine the possible presence of ozone and peroxyacetyl nitrate. Ozone causes a small fleck or dark stipple on the upper surface of mature, fully expanded leaves, while PAN causes silvering, glazing, or metallic sheen on the lower surface. To indicate the presence and obtain some information on the level of ozone, the tobacco varieties Bel-B (resistant), Bel-C (sensitive), and Bel-W3(supersensitive) are suggested. Other plants sensitive to ozone are spinach, radish, tomato, a white-flowered variety of petunia, and white pine. A synergistic action by ozone and sulfur dioxide has been discovered. It is possible that plant injury can develop when these pollutants are present at concentrations too low to produce injury as an individual pollutant. The injury in tobacco resembles that caused by ozone. Therefore, in areas where SO_2 is present, the level of ozone required to cause injury will be reduced.
Source: 1

#1359

Heggestad, H.E. and W.W. Heck. "Nature, extent, and variation of plant response to air pollutants." Advan. Agronomy, 23:111-145 (1971).

Nature, extent, and variations of plant response to air pollutants are reviewed. The most common phytotoxic air pollutants in the USA are ozone, sulfur dioxide, fluorides, peroxyacl nitrates, ethylene, nitrogen dioxide, pesticides, chlorine, heavy metals, acid aerosols, ammonia, aldehydes, hydrogen chloride, hydrogen sulfide, and particualtes, such as cement dust. Ozone and SO2 are widely distributed. In the USA, ozone seems to be causing more plant damage than any other air pollutant, but on a worldwide basis, SO2 is more injurious than ozone. Air pollution problems have increased because of multiple sources and mixtures of pollutants. There is increased concern about chronic injury and reduced growth attributed to air pollutants, such as photochemical oxidants and sulfur oxides. Ozone causes small necrotic spots on the upper surface of the leaves, PANs induce undersurface leaf injury in the form of glazing, silvering or bronzing, and SO2 exerts usually bifacial and interveinal attack with relatively large collapsed areas surrounding the larger green veins. Fluorides cause injury of leaf tip and margins. The effects of nitrogen dioxide resemble those of SO2 in acute incident. Response to pollutants may be altered by many factors, such as genetic, environmental, cultural conditions, time-concentration relationships, and the presence of mixtures of pollutants. The identification and use of tolerant varieties, including resistant varieties developed by breeding, will help reduce losses and assure maximum agricultural production.
Source: 1

#1358

Heggestad, H.E., F.S. Santamour, Jr., and L. Bernstein. "Plants that will withstand pollution and reduce it." In: Landscape For Living, Government Printing Office, Washington, D.C., pp. 16-22 (1972).

Ozone, peroxyacetyl nitrate, sulfur dioxide, nitrogen dioxide, fluorides, and ethylene are pollutants that singularly or in combination can cause damage to plants in the form of lesions, tissue collapse, discoloration, defoliation, premature aging, and necrosis of leaf margins and tips. The concentration of these pollutants is high enough in some areas to result in economic losses. The sensitivity of the plants can be used to detect the presence of these pollutants and to augment monitoring instruments. Trees and other plants also play a role in removing gaseous pollutants and particulates from the atmosphere and in reducing noise. The ginko and the Ailanthus are two species which have been grown successfully in urban areas. Natural selection will result in more resistant plants, but the cultivation of particular species is desirable.
Source: 1

#1361
Heggestad, Howard E., Kenneth L. Tuthill, and Robert N. Stewart. "Differences among poinsettias in tolerance to sulfur dioxide." HortScience, 8(4): 337-338 (August 1973).

Eight cultivars of poinsettia, Euphorbia pulcherriam Willd. ex Klotzsch., were exposed to sulfur dioxide under controlled environment conditions. The doses of SO2 were 1, 2, and 3 ppm for 3 hr and 3 ppm for 1 and 2 hr; 1 ppm SO2 is equal to 2617 micrograms/cu m (25 C, 760 mm Hg.). All cultivars showed more injury from SO2 when exposed to 3 ppm for 2 hr than 2 ppm for 3 hr, although the total dose was the same. A new cultivar, Ruff and Reddy, showed the most overall tolerance while Rudolph and Mikkel Blaze were least tolerant. The bracts of Annette Hegg were injured most by SO2, whereas the bracts of Ruff and Reddy and Eckespoint C-1 were not visibly injured at the dosage levels tested. The wide range in tolerance to SO2 among the eight different genotypes indicates a potential for breeding and selection of tolerant cultivars.
Source: 1

#988
Heichel, G. H. "Removal of carbon monoxide by field and forest soils." J. Environ. Qual., 2(4):419-423 (1973).

The removal of carbon monoxide from a stream of air flowing through a chamber containing soil, either from a forest or from a cultivated field, was measured in the laboratory by infrared gas analysis. The ambient CO concentration, the moisture content of the soil, and the turbulence of air above the soil modified the CO removal. The removal of CO by either soil increased with concentration between 2 and 40 ppm. Maximum rates of removal approached 0.20 mg CO dm^{-2} $hour^{-1}$. The pattern of removal was exponential with CO concentration in moist soil, and linear with CO concentration in dry soil. In the forest soil, an optimum water content for CO removal was apparent at about 55% (wt/wt). Removal of CO by the field soil increased up to about 5% water content (wt/wt), but it did not increase further as water content increased to about 15% (wt/wt). Removal of CO by the forest soil exceeded that of the field soil at all water contents when the two soils were compared at the same CO concentration. Stirring the soil enhanced the removal of CO by a crusted field soil that was dryer in the upper than in the lower part of the profile. Slowing the mixing of air over the forest soil decreased removal of CO 40 to 50% at two moisture contents. Analyzing the removal of CO by soil with a diffusion model suggests that the entry of CO into soil is exposed by a substantial diffusive resistance that varies with soil type, moisture content, turbulence of the air, and CO concentration. The measurements suggest that the soil surface of the earth removes CO at a minimum annual rate equivalent to 14% of the tropospheric inventory.
Source: 5

#76
Heichel, G. H. "Soil recycles carbon monoxide." Frontiers of Plant Science, 25(2):4-7 (Spring 1973).

Soils were found to exhibit vigorous removal of CO. The speed of removal increased with increasing concentrations of this pollutant. It was observed that CO is removed more effectively at high than at low gas concentrations and that moist soils cleanse CO from the air more rapidly than dry soils. Soils covered with a dry, hard crust remove CO slowly but tillage to expose a moister undersurface renews soil removal capacity. An atmospheric wind increases soil absorption of the gas.
Source: 7

#149
Heichel, G. H., and L. Hankin. "Particles containing lead, chlorine and bromine detected on trees with an electron microprobe." Environmental Science & Technology, 6:1121-1122 (1972).

Analysis of the bark of trees with an electron probe micro-analyzer revealed that lead, chlorine, and bromine are associated with particles, about 7 μm in diam, on or embedded in the bark. The similarity in elemental content is noted between the lead-bearing particles on trees and some of the compounds emitted in automobile exhaust.
Source: 7

#1797
Heichel, Gary H. and Lester Hankin. "Roadside coniferous windbreaks as sinks for vehicular lead emissions." Journal of the Air Pollution Control Association, 26(8):767-770 (August 1976).

The role of a roadside windbreak of white pine trees in modifying the dispersion of vehicular lead emissions was evaluated. The lead content of foliage and twigs of various ages adjacent to and far from the road was analyzed by atomic absorption spectrophotometry. The lead burden of older needles and twigs was consistently greater than that of younger organs, and was greater in samples taken adjacent to than far from the road. The pattern of lead accumulation on mature needles, but not twigs, varied with preceipitation prior to sampling. Twigs retained particles more effectively than needles throughout the season; twigs retained about 115% more lead as $\mu g\ g^{-1}$ and about 2050% more lead as $\mu g\ cm^{-2}$ than similarly located needles. The lead content of soil beneath the windbreak was compared with that of an adjacent, undisturbed field to assess whether the presence of the windbreak resulted in lead enrichment of the underlying soil. The soil between the curb and the windbreak contained about 50% more lead than that of the field at a similar distance from the road. Within the windbreak, the soil contained about twice the lead content of the soil in the open field at a similar distance from the curb. Windbreaks function as sinks for vehicular lead emissions and thus decrease their dispersion from roads.
Source: 8

#375
Heichel, G. H. and L. Hankin. "Roadside coniferous windbreaks as sinks for vehicular lead emissions." The Connecticut Agricultural Expt. Station, P. O. Box 1106, New Haven, CT. 06504. (1976).

The role of a roadside windbreak of white pine trees in modifying the dispersion of vehicular Pb emissions was evaluated. The Pb content of foliage and twigs of various ages adjacent to and far from the road was analyzed by atomic absorption spectrophotometry. The Pb burden of older needles and twigs was consistently greater than that of younger organs, and was greater in samples taken adjacent to than far from the road. The pattern of Pb accumulation on mature needles, but not twigs, varied with precipitation prior to sampling. Twigs retained particles more effectively than needles throughout the season; twigs retained about 115% more lead as ug g^{-1} and about 2050% more lead as ug cm^{-2} than similarly located needles. The lead content of soil beneath the windbreak was compared with that of an adjacent, undisturbed field to assess whether the presence of the windbreak resulted in lead enrichmentof the underlying soil. The soil between the curb and windbreak contained about 50% more lead than that of the field at a similar distance from the road. Within the windbreak, the soil contained about twice the lead content of the soil in the open field at a similar distance from the curb. Windbreaks function as sinks for vehicular lead emissions and thus decrease their dispersion from roads.
Source: 7

#1842
Heilbronn, Alfred. "Ueber die physiologische Wirkung der Industriegase auf Pflanzen." (Industrial waste gases: Physiological action on plants). Forsch Fortschr., 6(30):392-393 (Oct 1930).

The possible dependance of pollutant concentration thresholds of environmental factors was investigated on clover, tomato, cucumber, soybean, and Callisia. One group was exposed to natural industrial air and the other to purified air in two-chamber greenhouses installed in an industrial area. The ventilation was made every 30 min for 15 min. A third group was exposed to industrial air in open area. No smoke damage could be revealed on plants in the greenhouse, and a number of functions were even stimulated in the greenhouse smoke chamber, compared to plants in open air. An increase of 21% (average of 17 days) in the rate of growth was found for California shoots and roots, compared to Callisia cultures in the pure-air chamber. Callisia cultures in the pure-air chamber, fed with after from waste gas cleaning also showed increased rates of growth. Both increased assimilation activity and water runoff were observed in the smoke chamber. The differences in the behavior of smoked and open-air plants may be explained from a number of conditions. The fluctuations between maximum and minimum concentrations were less important in the greenhouse than in the atmosphere.
Source: 1

#1479
Heines, T. S., and L. K. Peters. "The effect of ground level absorption on the dispersion of pollutants in the atmosphere." Atmos. Environ., 8(11):1143-1153 (November 1974).

The emission of an air pollutant species from a point or line source is analyzed for a case in which the pollutant may be absorbed (or desorbed) at ground level. Solution of a mass conservation equation leads to expressions which describe the concentrations downstream from the emission source, with the ground level concentrations being presented in the form of dimensionless plots. Typical numerical values for the parameters in the equations are used to show that the concentration profiles over water in the vicinity of the emission source are appreciably affected only for very soluble gases such as sulfur dioxide, ammonia, and hydrogen chloride. While oceans may serve as important repositories for less soluble gases such as carbon monoxide and carbon dioxide; the ground level concentrations of such gases over water near an emission source are not likely to be affected very much by the rate of absorption or desorption.
Source: 1

#1171
Heisler, G. M. "Trees and human concept in urban areas." Journal of Forestry 72(8) (August 1974).

The most important contribution of trees to amelioration of urban microclimate is in interception of solar radiation. Shielding of long-wave radiation by trees has usually been underemphasized. Transpiration by trees may be important in urban energy budgets, but the total effect of transpiration by city trees is not well understood. Use of trees for control of air flow requires care because in summer increased wind speed is desired, but in winter trees can greatly increase human comfort by reducing wind speed. Metabolism and photosynthesis by trees have no significant impact on microclimate.
Source: 6

#473
Heller, R.C. "Large scale photo assessment of smog damaged pines." In: New Horizons in Color Aerial Photography, United Kingdom Scientific Mission (England), Rept. 69/51, p. 85-98 (August 1969).

A feasibility study was performed on Ponderosa pine dying from air pollutant in the mountains surrounding Los Angeles to determine if aerial photographs could detect loss of vigor and mortality. Five combinations of films and filters were used at five photographic scales ranging from 1:1584 to 1:32,000. Normal color film taken at a very large scale (1:1584) with a didymium filter related very closely to ground conditions (r 0.97). This combination was best for evaluating all levels of smog injury. Detection of advanced smog injury could be picked up about 80% of the time in color or false color film at a scale of 1:8000. Through the use of discriminant analysis techniques, the number and vigor of affected pines on the ground can be predicted accurately from interpretations of large scale color transparencies.
Source: 1

#155
Helvey, J. D. "A summary of rainfall interception by certain conifers in North America." Biological Effects in the Hydrological Cycle. 3rd Int. Sem. Hydrology Prof. Proc. Purdue University 103-113 (1971).

Paper combines available interception results from coniferous stands growing in North America in order to determine gross similarities and differences in interception losses between species. Results should be useful for general problems such as modeling the water balance of watersheds supporting various combinations of species. Some general conclusions: canopy-interception loss is greatest in the spruce-fir-hemlock type, intermediate in pine, and least in broad-leaved deciduous forests; surface area index correlates well with interception. Fir and hemlock forests transpire more heavily than pine and hardwood forests. In general, evaporative losses highest from spruce-fir-hemlock type; lowest from hardwood type; pine intermediate.
Source: 7

#1363
Hemphill, D. D., C. J. Marienfeld, R. S. Reddy, W. D. Heidtage, and J. O. Pierce. "Toxic heavy metals in vegetables and forage grasses in Missouri's lead belt." J. Assoc. Offic. Anal. Chemists, 56(4):994-998 (1973).

The effect of the lead mining operations in southeastern Missouri on the toxic heavy metal content of vegetable crops and forage grasses was studied. Lettuce, radishes, and greenbeans grown in seven counties in S.E. Missouri and three control counties in N.E. Missouri were analyzed for toxic metals. All samples were washed in distilled water. Atomic absorption analyses detected the following maximum levels of lead in the Southeastern samples (in micrograms/g dry weight): lettuce leaf, 1324; radish root, 518; and greenbean pods, 136. The cadmium levels in micrograms/g dry weight were: lettuce leaf, 34.5; radish root, 13.7; and greenbean pods, 8.5. Vegetables from the control counties contained markedly lower levels of these metals. Because considerable quantities of lead ore are transported from the mining area in S.E. Missouri to smelters in other areas, forage grasses (Festuca arundinacea and Tridens flavus) were collected along ore trucking and control routes. Maximum levels of lead (4350 micrograms/g dry weight, unwashed) and cadmium (4.32 micrograms/g dry weight) were detected in the grasses taken from the trucking routes. Considerably lower levels were detected in the grasses from the control routes. Although contamination of forage grasses in the mining area has been connected with the deaths of several horses, no positive correlations have yet been established between the toxic heavy metals concentrations in the vegetables from this region and human health parameters.
Source: 1

#1278
Hemphill, D. D., C. J. Marienfeld, R. S.Reddy, and J. O. Pierce. "Roadside lead contamination in the Missouri lead belt." Arch. Environ. Health, 28:190-194 (April 1974).

The lead content of soils and vegetation along highways used for truck transport of lead concentrate (essentially lead sulfide) from mines and mills to smelters was compared with that of control routes with comparable amounts of traffic but no ore transport. Greatly elevated levels of lead were present in the soils and vegetation along rights-of-way of ore truck routes, with contamination being limited for the most part to 100 years or less. The dispersal of lead sulfide dust could be largely prevented by the use of tight covers on the ore vats of the transport trucks.
Source: 1

#201
Herath, H.M.W., and D.P. Ormrod. "Temperature and sulfur nutrition effects on CO_2 compensation values in barley, peas, and rape." Plant Physio., 49(3):443-444 (1972).

The purpose of this study is to determine whether the sulfur nutritional status of the plant affects its carbon dioxide compensation values, and if such effects are temperature-dependent. Plants of barley, rape, and peas were investigated. Highly significant differences in CO_2 compensation values were obtained between temperature regimes. There are significant interactions between temperatures and S level in both the CO_2 compensation values and the S content of leaves, indicating that S uptake as well as the effect of S on CO_2 compensation values were both dependent on temperature. The results showed clearly that sulfur nutrition status will affect the CO_2 compensation values of high compensation plants, and that the magnitude of the effect could be modified by the temperature at which the plants are grown.
Source: 1

#1950
Herbst, W. "Filter- und Schutzwirkung des Waldes gegen radioaktive und andere Beimengungen der Atmosphaere." (Filtering and protective effect of forests against radioactive and other impurities of the atmosphere). Forst. Holzwirt Schaft, 20(10):216-220 (1965).

Studies on the filtrating and protective effect of forests against radioactive and other air pollutants are reviewed. While forests do not represent a control for air pollution they do have a considerable relative protective effect against both particulate and gaseous air pollutants. The filtration efficiency of forests for particulate radioactive air pollutants is as high as for non-radioactive particulate matter. Experiments revealed much higher pollutant concentrations on the weather side of forests than on the lee side. Also, the dust deposits on leaves on the weather side were much higher than those on the lee side, even on the same tree.
Source: 1

507

Hettche, H.O. "Pflanzenwachse als Sammler fuer polyzyklische Aromaten in der Luft von Wohngebieten." (Plant waxes as repositories of polycyclic aromatic hydrocarbons in the atmosphere of inhabited areas). Staub, Reinhaultung Luft, 31(2):72-76 (February 1971).

Green kale was a suitable sampler for the determination of the rate of deposition of polycyclic aromatic hydrocarbons. The cuticle of kale is hydrophobic, the outer leaf contains 33 micron/sq m ether-soluble wax which absorbs and protects, lower aromatic hydrocarbons which would evaporate if the dust containing polycyclic aromatic hydrocarbons was deposited on a filter. Thirteen aromatic hydrocarbons including phenanthrene, anthracene, pyrene, fluoranthene, benz(a)anthracene, chrysene, benzo(e)pyrene, benzo(a)pyrene, perylene, anthranthrene, benzo(ghi)perylene, dibenz(a,h)anthracene, and coronene were isolated from a methanol extract of the wax deposit on kale. The relationship between the 3,4-benzpyrene and benzo(a)pyrene content and that of coronene and benzo(ghi)perylene is an indicator of the pollution suitable for the determination of the cancerogenicity of the atmosphere. The emission of 3,4-benzpyrene in urban areas can also be determined by means of paper impregnated with beeswax.
Source: 1

#989

Hidy, G.M. "Removal processes of gaseous and particulate pollutants." Chem. of the Lower Atmosphere, S.I. Rasoal (ed.). Plenum Press, New York (1973).

In an age of increasing pressures placed on the earth's resources, there is great concern for the atmosphere's ability to cleanse itself of anthropogenically generated material. Indeed, the earth's atmosphere has been overloaded locally with pollution, particularly over cities, to create rather unhealthy and aesthetically unpleasant living conditions. On larger scales, there is conflicting evidence of man's intrusion into the natural composition of the atmosphere. Perhaps the best evidence for anthropogenically stimulated imbalances between production and removal of trace constituents are the data on the continuing increase of carbon dioxide in the air. A variety of different observations has indicated that the atmospheric CO_2 concentration has increased at a rate of about 0.2% per year during the period between 1958 and 1969. Other evidence such as that reported for global decreases in visibility is less well documented, and independent evidence of emission surveys does not confirm a serious increase in global haze development by anthropogenic sources. The disturbance of the average composition of the atmosphere as we know it depends on upsetting a delicate balance between production of trace materials from a variety of sources and the removal of such substances by diverse mechanisms. If the dynamical processes in the atmosphere cannot rid the air rapidly enough of pollutants, they will increase in concentration to higher and higher levels. Since man's activities will continue to accelerate the emission of pollutants, it is now urgent that we develop a much better ability to assess and forecast the consequences of increased concentration levels of such materials. Thus, it has become important not only to identify and quantify natural and anthropogenic emissions, but also to formulate quantitative models for estimating the lifetime of gaseous and particulate emissions from the atmosphere.
Source: 5

#308
Hidy, G. M., and J. R. Brock. "An assessment of the global sources of tropospheric aerosols." (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper ME-26A.) Preprint, International Union of Air Pollution Prevention Associations, 41 p. (1970).

Based on current knowledge of the sources and production mechanisms of tropospheric aerosols, an assessment is made of the relative contribution of material from natural and anthropogenic origins. The survey indicates that more than half of the aerosol presently in the lower atmosphere comes from 'secondary' processes such as chemical reactions in the gas phase. The principal known or suspected participants in such reactions are volatile hydrocarbons, nitrogen oxides, ammonia, and sulfur compounds such as hydrogen sulfide and sulfur dioxide. The man-made contribution at this time amounts to about 6% of the total production rate, which is set at approximately 10 to the seventh power tons/day. A projection of the expected production rate assuming middle 1960 control methods suggests that the anthrogenic portion will increase the total aerosol concentration in the troposphere by about 11% through the year 2000. This increase will reduce the visibility by a corresponding amount, and it may reduce the amount of solar radiation reaching the earth's surface about 2% in the middle latitudes.
Source: 1

#1113
Hiechel, G. H. "Plants, oxygen, and people." Front. Plant Sci., 24(1):6-7 (1971).

The oxygen cycle is related in the article with emphasis on the roles of man and plants in the consumption and production of oxygen.
Source: 8

#88
Hill, A. C. "Vegetation: a sink for atmospheric pollutants." Preprint, Air Pollution Control Assoc., Pittsburgh, Pa. (Presented at the Air Pollution Control Association, Annual Meeting, 64th. Atlantic City. June 27-July 2, 1971. Paper 71-66 39p.). Journal Air Pollution Control Association 21(6): 341-346 (1971).

The possibility of vegetation being an important sink for gaseous air pollutants was investigated. Plant pollutant uptake measurements were made utilizing a typical vegetation canopy and chambers that were designed specifically for gaseous exchange studies. An alfalfa canopy was indicated to remove gases from the atmosphere in the following descending order: hydrogen fluoride, sulfur dioxide, chlorine, nitrogen dioxide, ozone, peroxyacetyl nitrate, nitric oxide, and carbon monoxide. The absorption rate of NO was low and no absorption of CO could be detected by the methods used. In the typical ambient concentration range, uptake increased linearly with increasing concentration except for O3 and Cl2 which caused partial stomatal closure at the higher concentrations. Wind velocity above the plants, height of the canopy, and light intensity were shown to affect the pollutant removal rate. A relationship between the absorption rate and solubility of the pollutant in water was also shown.
Source: 1, 2, 6

#1491

Hill, A. C. "Air quality criteria for fluoride vegetation effects." J. Air Pollut. Contr. Assoc., 19:331-336 (1969).

Facts that must be taken into consideration in developing fluoride standards for vegetation effects include: (1) Fluoride is an accumulative toxicant and injury is usually associated with long-term exposure; (2) gaseous and particulate fluorides differ in their phytotoxicity; (3) plant species and varieties differ greatly in susceptibility to fluoride; (4) extremely low concentrations can cause damage to sensitive species. Three possible approaches to standards are discussed: Atmospheric fluoride concentration, vegetation fluoride concentration, and the presence of leaf necrosis or chlorosis. Atmospheric fluoride concentration has the advantage that it fits the conventional concept of standards and that it is objective. Accurately measuring low fluoride concentrations, separating gaseous from particulate fluorides in the air sample, and establishing a safe concentration present technical problems, however. Vegetation analysis may more closely represent fluorides available to affect the plant. The presence of significant amounts of fluoride-induced leaf necrosis (e. g., 3% of the leaf area) may be the most practical approach to standards for fluoride vegetation effects. Advantages are that the combined effects of the forms of fluoride, species and varieties, and concentration-time relationships are all manifest in the factor that is measured. Relatively little time is required to examine the vegetation in a large area and only 2 or 3 surveys a year are required.
Source: 5

#1365

Hill, A.C. , T. W. Barrett, S. Hill, and C. Lamb. "Sensitivity of native desert vegetation to SO2 and SO2 plus NO2." (Presented at Air Pollution Control Association, Annual Meeting, 66th. Chicago. 21 p.) (June 24-28, 1973).

Interest in possible air pollution-related injury to native species was generated with the construction of several large coal-fired power plants in the southwest desert areas of Utah, New Mexico, Arizona, Colorado, and Nevada. The effects of sulfur dioxide and sulfur dioxide plus nitrogen dioxide, the two major phototoxic pollutants emitted from coal-fired power plants, on native vegetation were studied via fumigation experiments in which portable chambers were placed over 87 plant species in the field. Pollutant concentrations were measured and controlled with instruments located in a mobile laboratory. Each of the 186 fumigations lasted for 2 hr, with the pollutant concentrations ranging from 0.5 to 11 ppm SO2 and 0.1 to 5 ppm NO2. The SO2 concentrations above 2 ppm caused injury to all but a few of the species studied, and many of the plants proved to be highly resistant to injury from the pollutants. No evidence of synergism between SO2 and NO2 was detected. When SO2 injury occurred, it appeared within a few days of fumigation. The most common sign of injury was leaf necrosis, with middle-aged and older leaves being more susceptible to injury than younger, expanding leaves.
Source: 1

#1366
Hill, A. C., and J. H. Bennett. "Inhibition of apparent photosynthesis by nitrogen oxides." Atmos. Environ. (London). 4(4):341-348 (1970).

The nitrogen oxides (nitrogen dioxide and nitric oxide) inhibited apparent photosynthesis of oats and alfalfa at concentrations below those required to cause visible injury. There appeared to be a threshold concentration of about 0.6 ppm for each pollutant. Plant fumigations are conducted in air-tight, internal recirculation environmental chambers. Apparent photosynthesis rates were determined by adding pure carbon dioxide serially into each chamber through a solenoid-controlled panel; the NO2 or NO was diluted and pressurized with nitrogen before being added to the fumigation chamber. An additive effect in depressing apparent photosynthesis occurred when the plants were exposed to a mixture of NO and NO2. Although NO produced a more rapid effect on the plants, lower concentrations of NO2 were required to cause a given inhibition after 2 hr of exposure. Inhibition by nitric oxide was more closely related to its partial pressure than was inhibition by NO2.
Source: 1

#69

Hill, A. C., and E. M. Chamberlain, Jr. "The removal of water soluble gases from the atmosphere by vegetation." Presented at the Atmospheric-Surface Exchange of Particulate and Gaseous Pollutants, Richland. (September 4-6 1974).

The absorption of water soluble gases by a typical vegetation canopy was investigated using environmental chambers specifically designed for this purpose. These chambers were constructed to simulate, within acceptable limits, different field environmental conditions by controlling wind velocity, CO_2 concentration, temperature, relative humidity, light intensity, and pollutant concentration.

Standard alfalfa canopies removed gaseous pollutants from the atmosphere in rates of the following order: hydrogen fluoride (HF) Sulfur dioxide (SO_2) chlorine (CL_2) nitrogen dioxide (NO_2) ozone (O_3) peroxyacetyl nitrate (PAN) nitric oxide (NO) carbon monoxide (CO). HF, SO_2, and NO_2 concentration profiles indicated that these substances were efficiently removed from the atmosphere by the surface and subsurface vegetation of the upper portion of the plant canopy.

Wind velocity, canopy height, and light intensity were shown to affect the rate of pollutant removal by the vegetation. The rate of pollutant removal was also found to increase linearly with the increase of pollutant concentration over the ranges of concentration which may be found in ambient air and which are low enough not to cause stomatal closure. The absorption rate of the various gaseous pollutants was shown to be related to their solubility in water.

It was concluded that vegetation may be an important sink for many gaseous air pollutants.
Source: 8

#1871

Hill, A. C., H. E. Heggestad, and S. N. Linzon. "Ozone." In: Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas. Jay S. Jacobson and A.Clyde Hill (eds.), Pittsburgh. Air Pollution Control Assoc. p. B1-B22, 1970.

Ozone probably causes more injury to vegetation than any other air pollutant in the United States. Varietal and species differences in ozone sensitivity have been observed. Some of the species which have been injured in the field or which have appeared sensitive in fumigations are listed. The most common symptom on many deciduous trees and shrubs is localized thickening and pigmentation of the cell walls resulting in sharply defined small dot-like lesions. Small unpigmented necrotic spots or more general upper-surface bleaching is a common type of injury on most herbaceous and many wooded species. When all of the tissue of the leaf is killed, relatively large bifacial necrotic areas develop. Necrotic tissue ranges from white to orange-red depending on the species. On leaves with palisade parenchyma, chlorotic lesions are usually limited to small groups of palisade cells, and the injury is observable primarily on the upper leaf surface. Grasses with undifferentiated mesophyll may develop a fine chlorotic stippling on either surface. Chlorotic mottling and flecks are the common symptoms on pine. Symptoms of ozone injury on selected species are also discussed.
Source: 1

#1114

Hill, A.C. and N. Littlefield. "Ozone: Effect on apparent photosynthesis, rate of transpiration, and stomatal closure in plants." Environ. Sci. Technol., 3(1):52-56 (1969).

Little is known regarding the cause of plant growth suppression resulting from photochemical pollution. Studies with ozone indicate that elevated ozone concentrations may be involved. Ozone induced partial stomatal closure and a reduction in apparent photosynthesis and transpiration. High concentrations of ozone caused a temporary reduction in apparent photosynthesis of many species, often with little or no injury developing. The effect was reversible and plants frequently recovered within a few hours. Ozone concentrations as low as 10 p.p.h.m. for several hours caused partial stomatal closure of oats. A comparison of the effects of ozone under sunlight and artificial lighting showed that photosynthesis was reduced most in sunlight.
Source: 8

#474

Hill, D.J. "Experimental study of the effect of sulphite on lichens with reference to atmospheric pollution." New Phyto., 70(5):831-836 (Sept. 1971).

The relative sensitivity of three lichens to sulfite solutions matches their relative sensitivity to atmospheric pollution as observed in the field. If it is assumed that exposure to sulfite is equivalent to exposure to sulfur dioxide, this result is the first direct experimental evidence which supports the conclusion that SO_2 is the substance in pollu-

tion that governs the distribution of lichens. Usnea subfloridana is fruticose, Parmelia sulcata foliose, and Lecanara conizaeoides crustose. Fruticose and foliose lichens tend to be more sensitive to atmospheric pollution than crustose lichens. These differing sensitivities to sulfite were correlatd with the known sensitivities of these lichens to atmospheric pollution. Sulfate was less toxic than sulfite. Sulfite was toxic at a four pH and below but not toxic at pH five and above.
Source: 1

#1478

Hill, Frank B. "Atmospheric sulfur and its links to the biota." Brookhaven National Lab., Upton, N.Y., Carbon Biosphere, Proc. Brookhaven Symp. Biol., 24th, Upton, N.Y., p. 159-181 (Aug 1973).

The atmospheric sulfur cycle is reviewed with emphasis on its connections to the biota. Biometeorological factors affecting rates of uptake of sulfur dioxide by vegetation, the use of regional atmospheric pollution models to predict acidity in precipitation, and factors affecting emission of biogenic sulfur compounds into the atmosphere are discussed. Sulfur occurs in the atmosphere principally as hydrogen sulfide, SO2, and sulfates originating respectively, from the nonspecific reduction of organic sulfur and sulfate reduction by anaerobic bacteria; from oxidation of H2S, combustion of fossil fuels, and volcanic action; and from sea spray and oxidation of H2S or SO2. The global atmospheric sulfur budget totals 183 times 10 to the 6th power tons/yr from human activity, biogenic H2S, and sea spray sulfate. Sinks include precipitation, dry deposition, absorption of SO2 by vegetation and soils, and absorption of SO2 by oceans. Sulfur dioxide absorption by vegetation and soils, sulfate removal by precipitation scavenging, and the emission of biogenic H2S are discussed in detail.
Source: 1

#1367

Hillimann, R.C. "Biological effects of air pollution on insects, emphasizing the reactions of the honey bee (Apis mellifera L.) to sulfur dioxide." Pennsylvania State Univ., University Park, Dept. of Entomology, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 170 p. (March 1972).

Ecological responses of insects to environmental air pollution by sulfur dioxide were investigated. Chronic SO_2 toxicity tests on the honey bee, Apis mellifera L., were conducted under controlled conditions to determine the influence of SO_2 upon brood rearing, pollen collection, worker bee mortality, flight activity, honey production, and intrahive behavior. Investigations to determine intrahive SO_2 contamination of honey, pollen, larvae, and adults were also performed. Honey bee eggs, larvae, pupae, and adults were also exposed to acute 1000 ppm SO_2 fumigations to determine the relative sensitivity to SO_2 among life stages. Behavioral responses of adult honey bees were monitored during the acute fumigations to determine the sensitive biological systems. The deleterious effects of SO_2 noted in field studies were confirmed during controlled chronic honey bee fumigations

with SO_2. Significant reductions in brood rearing among fumigated colonies led to correlated declines in pollen collection. Both brood rearing and pollen collection exhibited inverse linear relationships with increasing SO_2 concentrations. Control colonies exhibited significantly more flight activity than fumigated colonies, and the reduced number of flights by fumigated colonies contributed to concurrent reductions of stored honey and colony weights. Sulfur dioxide's effect upon bee mortality was unclear. No significant differences in sulfur percentages were detected between fumigated and nonfumigated samples of adult or larval honey bees, honey or pollen. The acute SO_2 exposures revealed that of the four honey bee life stages, adults were the most sensitive to SO_2, followed in order by larvae, eggs, and pupae. Behavioral aberrations during acute SO_2 exposures progressed as follows: hyperactivity, scent gland exposure, equilibrium loss, mouthpart and appendage cleaning, crescent body shape, vigorous abdominal pulsation, salivation, excessive moisture accumulation on the exoskeleton, torpidity, and death.
Source: 1

#1369

Hindawi, I. J. "Injury by sulfur dioxide, hydrogen fluoride, and chlorine as observed and reflected on vegetation in the field." J. Air Pollution Control Assoc., 18(5):307-312 (May 1968).

Plants were examined at three different locations in the eastern part of the U. S. to determine whether damage from air pollution had occurred. Sulfur dioxide damage occurred in New York City; hydrogen fluoride occurred near a glass fiber manufacturing plant in the midwest; and hydrochloric acid mist and chlorine damage from a manufacturing operation occurred in an eastern state. The symptoms that developed in the vegetation were often similar. Chemical and microscopical analyses were helpful in diagnosing the toxicants. Pollutant concentrations were measured in the areas studied. Plant damage from SO2 and/or acid mist results from conversion of SO2 to sulfur trioxide and then to sulfuric acid. The effects of SO2 in the ambient air were more severe than those produced in the laboratory with the same concentration of SO2 because of an additional chemical reaction attributed to ozone in the ambient air. Sulfur dioxide affected leaves, roots, stems, and plant color. The leaves of gladiolus plants, grown downwind of the fluoride source, were damaged by high concentrations of F in the area. Hydrogen chloride and chlorine levels in the eastern state were higher than concentration thresholds causing plant damage.
Source: 1

#802

Hindawi, I.J. "Air pollution injury to vegetation." Public Health Service, Raleigh, N. C., National Air Pollution Control Administration, 44 p. (1970).

Pollutant gases causing damage to vegetation, their sources, the principal plants each affects, and the symptoms of damage are reviewed and illustrated with full color photographs. Gases considered include ozone, peroxyacetyl nitrate, nitrogen dioxide, sulfur dioxide, hydrogen fluoride, chlorine, and ethylene. Both the acute and chronic damage caused by SO_2 are described as in the synergistic effect of ozone and SO_2 working in combination. Types of damage described and illustrated include necrosis, fleck,

stipple, silvering, bronzing, tip and margin burn, withering, leaf abnormalities, early abscission, dwarfing, and growth suppression. The structure and function of leaves and the mechanisms of damage are described. Damage thresholds are listed in terms of concentration and term of exposure. Plants as indicators of pollution are discussed, and representative samples are named. Agents other than air pollutants causing plant damage are identified and the similarity of symptoms among these agents and toxic gases is discussed, Twenty-seven varieties of vegetation damaged by air pollution are pictured. Comment is made on the geographic extent of air pollution plant damage. The cost of pollutant damage to vegetation is estimated nationally to be 500 million dollars annual California alone suffers an estimated 132 million dollars damage annually and a 50% loss of the citrus fruit crop.
Source: 1

#1368
Hindawi, I.J., and H.C. Ratsch. "Growth abnormalities of Christmas trees attributed to sulfur dioxide and particulate acid serosol." (Presented at the Air Pollution Control Association Annual Meeting, 67th, Denver, Colo., June 9-13, 1974, Paper 74-252.) Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 21 p. (1974).

Field surveys are presented of the cause of growth abnormalities of commercially grown scotch pine in West Virginia and Maryland. The abnormalities included short needles, premature needle drop, bud failure, and stunted growth. Five separate studies conducted during the summer of 1970, 1971, and 1972 included: visual examination of diseased and healthy needles to determine if symptoms of air pollution injury were present; exposing sensitive plants to ambient air or carbon filtered air at two sites in the area; exchanging injured trees from a plantation in which many trees were injured with healthy trees from a plantation of healthy trees; grafting of healthy scions to diseased trees and diseased scions to healthy trees to determine if infectious agents were involved; and exposing scotch pine to acid mist during needle growth and development. Native vegetation in the area displayed symptoms of sulfur dioxide injury. The degree of growth abnormalities in the scotch pine decreased with increasing distance from coal burning power plant, suggesting that sulfur dioxide and/or particulate matter may be related to the growth abnormalities seen. Sensitive plants were injured and their growth suppressed only when exposed to ambient air. Healthy scotch pine moved to a diseased plantation developed some injury and diseased trees moved to a healthy plantation showed some recovery. Grafting experiments indicated that the growth abnormalities were not caused by infectious agents. Controlled exposure in 1972 and 1973 demonstrated reproducible short needle syndrome in scotch pine exposed to sulfuric acid aerosol.
Source: 1

#1370
Hinners, T. A., J. E. Bumgarner, and W. S. Simmons. "Extraction of cadmium from rice." Preprint. Environmental Protection Agency, Research Triangle Park, N. C., Bienvironmental Lab. Branch. 4 p. (1974).

Two methods of analyzing cadmium in rice and other foods were compared on four samples of Japanese rice. The methods were extraction and total digestion. Portions of the dry rice samples were extracted for 16 hr with 1% nitric acid at room temperature; other portions were subjected to digestion with concentrated nitric and perchloric acids. Cadmium analysis was achieved by flame atomic absorption spectrophotometry with the use of sampling boats. A deuterium background corrector was used to cancel any noncadmium absorption. Digestion results were 0.26, 0.47, 0.23, and 1.8 micrograms/g; extraction results were 0.32, 0.42, 0.22, and 1.7 micrograms/g, respectively. Sample heterogeneity may account for the minor differences between the values. Extraction can be used to remove several metals from human hair.
Source: 1

#1353
Hirai, A. and F. Tsuda. "Taiki osen ni yoru shokubutsu yo no yoryokuso ganryo no henka." (The change of the amount of chlorophyll contained in plant leaves caused by air pollution). Kinki Daigaku kogai kenkyusho, Kenkyu Hokoku (Kinki Univ. Pollut. Res. Inst. Rep.), 1:175-180 (June 1973).

The blades of various kinds of plants were dipped under constant conditions in solutions of constant concentrations of sodium azide (NaN3), sodium fluoride, and sodium sulfite which were used as examples for air pollutants. The chlorophylls of these leaves were extracted with ether and acetone. Each absorption at 624, 644, and 663 nm was measured with a spectrophotometer, and the amounts of chlorophyll a and those of chlorophyll b were calculated. When the leaves were dipped in these drug solutions, the total amounts of chlorophyll decreased before signs of the disease visible with the naked eye occurred. Chlorophyll a decreased much more than chlorophyll b did. The ratio of chlorophyll a/b decreased when the leaves were dipped in these drug solutions compared with the blank leaves dipped in water. On the other hand, the ratios of chlorophyll a/b of leaves etiolated by virus disease and of leaves etiolated and weak by physiological causes were no different from that of healthy leaves. The decrease in the ratio of chlorophyll a/b depended on the characteristics caused by the actions in these drug solutions.
Source: 1

#1285
Hirano, H. "Shigaichi taiki osen busshitsu ni kansuru kenkyo." [Studies on air pollutants in city streets]. In: Taiki osen oyobi suishitsu odaku no jintai ni ataeru eikyo chosa kenkyu. (Investigation and research on the effect of air and water pollution on the human body). 2 p. (1971).

In order to clarify the natural purification mechanism of toxic gases, experiments were conducted using pollutants and soil. Carbon dioxide, nitrogen dioxide, sulfur dioxide, and acrolein were used. A 1 kg sample of soil was put in air tight 50-liter containers, and various gases were supplied in a separate container, and the reduction rate of the gases was measured periodically. The results were compared with similar experiments using soil heated to 200 C for 30 min. Natural water content was returned

by adding bacterial free water. When the soil was not sterilized, 10,000 ppm CO reduced to 0 in 5 days. When the sterilized soil was used, the CO content rose slightly on the first day, returned to 10,000 ppm on the second day, and stayed at the same level for the duration of the experiment. The entire 50 ppm of NO2 disappeared in an hour when using either sterile or natural soil. With SO2, 20 ppm content reduced to zero in 1 hour with the natural soil; when using sterile soil, some of SO2 remained at the end of one hour. When using sterile soil without additional water, even more SO2 remained in the container. Acrolein was reduced drastically in the natural soil chamber, in 1 hr, gradually diminishing after that to 0 in 20 hr. In the sterile soil container, the original 5000 ppm declined gradually, and in 20 hr, about a half of the original amount remained. The above tests showed a general difference between bacterial reaction and physiochemical decomposition or adsorption of these gases in the natural environment.
Source: 1

#12

Hirano, Hideo, Iyomaro Hanasawa, Touru Shigeta, Mitsuo Yano, Ichiro Fujinuma, and Bunsaku Wakai. "Taikiosen boshi taisaku ni kansuru kenkyu dai 1 ho. Dojo no gasu joka no ni kansuru kenkyu." (Study on preventive measures against air pollution. I. Study on purification ability of soil against gas). Nippon Koshu Eisei Zasshi (Japan J. Public Health), 18(10):442 (1971).

Concrete which covers the ground completely stops the purification abilities of soil, such as dissolution, absorption, or softening of harmful substances including those which cause air pollution. Surface soil of volcanic ashes and subsoil consisting of 5 kg (ratio of contained water, 6.2-7%) was put into a 20 l water tank and tightly sealed. Another sample was also tight. Sealed in the same way after sterilization by heating for 30 min. at 200 C and supplementing the evaporated water. Then carbon monoxide, nitrogen dioxide, sulfur dioxide, and acrolein was introduced and the gas in the air was estimated. Carbon monoxide showed distinct difference when compared with the control; acrolein decreased as the time passed but, compared with the control, the absorption in the beginning period was great.
Source: 1

#1277

Hirano, Hideo, Shigeki Kobayashi, Kiyofumi Ishikawa, and Jin Tanaka. "Dojo biseibutsu no CO sesshu sayo ni tsuite." (On actions observed in ingestion of carbon monoxide by microorganism in soils). Chiba Daigaku Kankyo Kagaku Kenkyu Hokoku (Environ. Sci. Rep. Chiba Univ.), 1(1):69-72 (July 1973).

Microorganisms capable of ingesting carbon monoxide and oxidizing it to carbon dioxide were studied. Carbon monoxide is consumed after being introduced in a container with soil inside. If CO is repeatedly delivered to the container, the CO disappearance velocity increases. Ingestion of CO by bacteria is not observed when soils are compressed so that inter-soil

space disappears or oxygen in the air is substituted by nitrogen. Carbon monoxide-14 was swiftly ingested by bacteria. Carbon-14, however, started to disappear 5 days after ingestion. It must be discharged from the body of bacteria into the air after 14CO is ingested by bacteria. It is still not clear whether 14C is discharged in the form of 14CO or 14CO2. In order to solve this problem, bacteria were cultivated by solid culture. Bacteria which absorbed CO were floated in physiological saline solution. Bichloride of mercury was then added to kill the bacteria. As a result of CO2 was detected instead of CO. Carbon monoxide, therefore, must be oxidized swiftly.
Source: 1

#1371

Hirao, Y., and C.C. Patterson. "Lead aerosol pollution in the High Sierra overrides. Natural mechanisms which exclude lead from a food chain." Science, 184(4140):989-992 (May 31, 1974).

Most of the lead contained in sedge leaves and vole mountain meadow mice within one of the most pristine, remote valleys in the U.S. is not natural, but comes from smelter fumes and gasoline exhausts. The mice were studies in Thompson Canyon in the crest of the High Sierra mountains. Isotopic compositions of Thompson Canyon leads and urban sources were used to determine the origin of the Thompson leads. About 97% of the lead entering the Canyon was of industrial origin, and 98% of the lead entering the valley remained there. Lead deposition and snow lead input, lead output, lead in humus, metals in food chain (calcium, strontium, barium, and lead), and lead in sedge leaves and vole tissues were measured. In a food chain, natural mechanisms do not allow lead to accompany the bulk of the nutritive metals as they proceed to higher tropic levels. This exclusion can be expresssed quantitatively by a comparison of lead/calcium ratios at successive tropic levels. This ratio decreased by an overall factor of 200 in proceeding from rock to soil moisture to sedge to vole. This factor would have been 1200 if lead aerosols had not collected on sedge leaves and circumvented the tendency by sedge to exclude lead from the nutritive metals it absorbed from soil moisture.
Source: 1

#1373

Hiratsuka, N., M. Ito, M. Shinozaki, and M. Mako. "Taiki osen busshitsu ga engei sakumotsu to ni oyobosu eikyo ni kansuru shiken (1)-c. shihyo shokubutsu ni yoru higai jittai chosaho." (Experiments on the effects of air pollutants on horticultural crops: Part I. Investigation of local damage of horticultural crops. Sec. A. Investigation of the actual damage by air pollution using indicator plants). Text in Japanese. Kanagawa-ken Nogyo Sogo Kenkyujo Gyomu Nenpo (Ann. Rep. Kanagawa Prefect Agri. Integr. Inst.), 1973:74 (June 1974).

To see the actual state of the effects of air pollution, indicator plans such as mulberry trees, Satsuma-orange trees, ginkgos, zelkova trees, and pines were chemically analyzed for sulfur, fluorine, and several heavy metals, along with the air pollution data obtained at the monitoring points. The amounts of air pollutants decreased in the order of Ebina, Sagamihara.

Aikawa, and Shiroyama cities in Kanagawa Prefecture. Fluorine content of the air was on the average 1.0-1.4 micrograms/day/100 sq cm (filter paper method) and higher in the spring than summer. The sulfur content of mulberry leaves was about 1400 ppm without a local difference, and fluorine content was around 11ppm, a little higher in the middle part of the Prefecture and in Sagamihara. Sulfur content of Satsuma-orange leaves ranged 0.1-0.3%, higher in spring than summer; however, no local difference was noticed in sulfur and heavy metal in the leaves. The sulfur content of ginkgo, zelkova, and pine tree leaves was respectively 0.2-0.4, 0.1-0.2, and 0.05-0.15, lower in rural areas than in industrial areas.
Source: 1

#1372
Hiratsuka, N., and M. Shinozaki. "Yugai gasu ni yoru shokubutsu higai no kaiseki (1)-e. kuwa ni taisuru ozon, aryusan gasu no eikyo shiken." (Analyses of plant injuries due to harmful gases: Part I. Sec. E. Experiments on the effects of ozone and sulfur dioxide on mulberry trees.) Text in Japanese. Kanagawa-ken Nogyo Sogo Kenkyujo Gyomu Nenpo (Ann. Rep. Kanagawa Prefect. Agr. Inst.), 1973:73 (June 1974).

Seedlings of a 1-year cutting of mulberry trees were exposed to ozone, ozone then sulfur dioxide, sulfur dioxide then ozone, and sulfur dioxide then ozone, and further sulfur dioxide, the concentrations of ozone and sulfur dioxide being respectively 0.15-0.28 ppm (on the average 0.2 ppm) and 1 ppm. The period of each exposure was 6 hr in the daytime. No visible injury was observed on all the treated trees. The sulfur content of the leaves of treated trees, notwithstanding their position, increased by exposure to SO_2. The amount was larger as the period of exposure was longer. The sulfur content of leaves of the trees exposed to ozone before exposure to SO_2 was larger than that of the trees exposed to ozone after exposure to SO_2.
Source: 1

#475
Hitchcock, A.E., D. C. McCune, L.H. Weinstein, D.C. MacLean, J.S. Jacobson, and R.H. Mandl. "Effects of hydrogen fluoride fumigation on alfalfa and orchard grass: a summary of experiments from 1952 through 1965." Contrib. Boyce Thompson Inst., 24(14):363-385 (Jan.-March 1971).

The results of experiments on controlled hydrogen fluoride fumigation of alfalfa and orchard grass are presented. Alfalfa was relatively tolerant to HF with respect to the production of foliar lesions. Chlorosis appeared prior to necrosis or was induced at lower concentrations of fluoride. The symptoms were most intense along the margins of immature expanded leaflets of the leaves near the tips of main or axillary shoots. Mature leaves were more resistant. The most severe symptoms developed on alfalfa exposed for nine days to the highest dosage of HF (5.20 micrograms F/cu m). The tolerance of orchard grass was comparable. The high dosages of HF which induced foliar markings did not reduce the yield of crops harvested immediately after the fumigation or subsequently. Effects on growth, when determined, amounted to an increase in the fresh or dry weight of the plants. For each day of exposure to HF at 1 microgram F/cu m, the fluoride concentration of alfalfa tissue increased by 2-4 ppm, and that of orchard grass increased by about 1 ppm. During the post fumigation period (8-22 days), the concentration of fluoride in alfalfa tissue decreased by 50%.
Source: 1

#1073
Hitchcock, D. R. "Atmospheric SO_4 from biological sources." J. Air Pollut. Control Assoc., 210-220 (1976).

Bacterlogenic production of H_2S occurs in fine-grained anoxic muds, is promoted by organic and nutrient pollution of water, peaks in the warm months of the year, and is the source of most of the estimated 100 to 200 million tons of biogenic sulfur annually contributed to the global atmosphere. We tested the hypothesis that biogenic sulfur contributes to the atmospheric load of sulfate in urban and nonurban sites by statistical analyses of the 24 hour sulfate levels measured in 4 coastal and 3 inland nonurban sites where pollutant sulfur dioxide emissions are absent or negligible, and in 8 coastal and 10 inland urban sites, all located in New England or Middle Atlantic states.

Comparisons of annual and seasonal mean sulfate levels show that in nonurban groups summertime sulfate levels significantly exceed wintertime levels, and in summer, sulfate levels in urban sites are nearly the same as in nonurban sites. Comparisons of group sulfate means in 4 New York cities near extended bodies of polluted water with those in 10 inland upstate New York cities show significantly higher levels in the cities near polluted water in spring, summer, and fall and for the year as a whole, but not in winter, when the levels were similar. When the nonurban and urban sites are grouped for proximity to coasts (where bacterial sulfate reduction is active in sediments) paired groups of coastal and inland urban and nonurban sites show no significant differences in sulfate levels in summer and fall.

Studies of the summertime sulfate means in New York state show no evidence of an elevated anthropogenic background which could explain the high summertime sulfate level observed in one nonurban site in that state, while analyses of the day to day fluctuations in urban and nonurban sites support the conclusion that nourban sites have large local (biogenic) sulfate sources in summer and fall, and that local sulfate sources also exist in spring and may exist in winter.

We conclude that biogenic sulfate sources contribute most of the sulfate observed in the cities studied during summer and fall, and in some cities also contribute in other seasons. These biogenic contributions vary with local conditions and are estimated to contribute up to 6 $\mu g/m^3$ (50%) or more to the annual geometric mean sulfate levels observed in some cities located near extensive bodies of polluted water.
Source: 5

#803
Hluchan, E., J. Mayer, and E. Abel. "The influence of aluminum-works exhalations on the content of fluorides in soil and grass." Polnohospodarstvo, 10(4):257-262 (1964).

Between 1958 and 1962, fluoride analyses were carried out on 338 soil samples and 72 grass samples from the vicinity of an aluminum plant. Soil from the south side of the plant showed fluoride values as high as 91.0 mg. Values for the remaining area ranged from 4.8 to 53.1 mg, averaging 20 to 29 mg. In contrast, the average fluoride value for soil from an uncontaminated area

was 13.6 mg. Grass samples showed fluorides to a value of 118.7 mg in 100 g of dry substance, while the fluorine content of light dust reached a value of 5.0 mg/100 g of fresh grass. The content of fluorine compounds in soil and grass decreased with increasing distance from the plant. The determined values in the proximity of the plant represent a multiple transgression of the natural content of fluoride in soil and grass.
Source: 1

#1374
Hodges, G.H., H.A. Menser, Jr., and W.B. Ogden. "Susceptibility of Wisconsin Havana tobacco cultivars to air pollutants." Agron. J., 63(1):107-111 (Jan/Feb 1971).

Wisconsin Havana cigar tobacco cultivars were tested for susceptibility to air pollutants in a plant exposure chamber and in tobacco field. Gases used in the chamber were ozone, sulfur dioxide, and a mixture of the two. Ozone was the principal air pollutant to affect field grown plants. Havana 142 was the most susceptible cultivar to ozone fumigations and to ozone-induced field disorder, weather fleck. Havana 501 exhibited about half the leaf injury of Havana 142 when exposed to the same ozone conditions. Other cultivars that showed intermediate response were Havana 307, Havana 425 and Havana 503. No injury resembling Target Spot a nonpathogenic syndrome observed in Wisconsin on Havana 503, was produced in any of the tests. All injury resembled the ozone fleck consisting of punctate lesions on upper surfaces of mature leaves. A low concentration mixture of ozone (0.03 ppm) and sulfur dioxide gases used at the same rates caused no symptoms. Mixed gas injury differed very little from ozone flecks.
Source: 1

#1375
Hodgson, R.H., D. S. Frear, H.R. Swanson, and L.A. Regan. "Alteration of diphenamid metabolism in tomato by ozone." Weed Sci., 21(6):542-549 (Nov. 1973).

The effects of ozone fumigation on the metabolism of diphenamid (N,N-dimethyl-2, 2-diphenylacetamide) in the tomato was investigated and the metabolites were identified. Fumigation with low levels of O_3 had little effect on root absorption, translocation, or conversion of diphenamid to water soluable conjugates. However, the proportion of specific conjugates was markedly altered in O_3 fumigated plants. Twenty-four hr after treatment, the predominant conjugates formed in nonfumigated and fumigated tomato were the beta-glucoside (M-DAG) and the beta-gentiobioside (MDAGB), respectively of N-hydroxmethyl-N-methyl-2, 2-diphenylacetamide. The ratio MDAG:MDAGB was 8.2:1.0 in the nonfumigated tissue and 0.6-1.0 in O_3 fumigated tissue. This marked shift towards production of the more polar MDAGB was accompanied by a trend toward increased production of methanol insoluble residues. A compound having limited stability was extracted from tomato. Its probable structure was N-hydroxy-methyl-N-methyl-2, 2-diphenylacetamide (MODA), and it is a postulated intermediate in the formation of MDAG and MDAGB from diphenamid.
Source: 1

#1377
Hoeft, R. G. and L. M. Walsh. "Effect of carrier, rate, and time of application of S on the yield, and S and N content on alfalfa." Wisconsin Univ., Dept. of Soils. Madison. 16 p. (1971).

Field experiments were conducted at nine locations in Wisconsin to evaluate the effect of carrier, rate, and time of application of sulfur on yield, S uptake, and S and nitrogen content of alfalfa. Significant response to S was obtained at five of the nine locations. In the first year after application, sulfate sulfur (SO_4-S) carriers were more effective than prilled elemental-S, 88% S and 12% bentonite, in correcting S-deficiency of alfalfa. In the second year after application, the various S carriers were equally effective. The results of this study indicated that 28 and 56 kg S/ha as potassium sulfate (K_2SO_4) were adequate to correct S-deficiency for a one-year and two-year period after application, respectively. At least 56 kg S/ha as elemental-S was required to obtain a significant yield response and this occurred only in the second year after application. A spring application of K_2SO_4 was more effective than a fall application, and K_2SO_4 applied at a rate of 28 kg S/ha each year over a two-year period was more effective than a single application of 56 kg S/ha made at the beginning of the two-year period. No significant difference between spring and fall application of elemental-S was noted in the yield or S-uptake values. In the second year, a single application of elemental-S made at the beginning of the experiment was more effective than an equivalent rate applied on an annual basis. Significant yield response was observed when the concentration of S in the tissue was 0.22% S or less.
Source: 1

#476
Hoericht, W. "Waldverwuestung durch Rauch." (Forest devastation from smoke). Kranke Pflanze, 15:90-92 (1938).

The chief sources of gases (sulfur dioxide, sulfuric acid, hydrochloric acid, and hydrofluoric acid) that poison forests are domestic heating, cellulose, and other industry plants. The damages caused to trees by these gases are very different, so no diagnosis can be established. Due to their exposure, lasting for many years, pine woods are more sensitive to sulfur dioxide and other poisonour gases contained in air than deciduous trees. The symptom of the damage is, in general, the reddening of the leaves and needles. Even if the air does not contain harmful gases, the dust and soot deposited on leaves and other organs reduce the respiration activity of the plants. Employing species more resistent to smokes cannot be regarded as a genuine solution to the pollution problem in forestry.
Source: 1

#497
Hofstra, G., and R. Hall. "Injury on roadside trees. Leaf injury on pine and white cedar in relation to foliar levels of sodium and chloride. Can. J. Botany, 49(4):613-622 (April 1971).

Leaf injury to pine and white cedar trees adjacent to highways in Ontario was investigated and the results were correlated with distance from highway, leaf content of chloride and sodium, and wind direction. Foliar injury, measured quantitatively as the ratio of brown to total leaf tissue, and foliar levels of sodium and chloride higher than background levels were determined on trees up to 120 m from the highway, particularly on the downwind side, on the windward side of the tree, and on trees in exposed positions; leaf injury and content of sodium and chloride decreased with increasing distance from the highway. Salt applied to highway in the winter wind, and lower than average temperatures contributed to the damage. Leaf injury was also correlated with species of tree examined.
Source: 1

#1947
Hoigné, J. and H. Bader. "Ozonation of water: Role of hydroxyl radicals as oxidizing intermediates." Science, 190:782-784 (1975).

Hydroxyl radicals are the main oxidants formed in the decomposition of ozone in water. This is demonstrated by measuring the relative rates at which different substrates are consumed and comparing them with known reaction rate constants. Knowledge accumulated by radiation chemists and biologists on the reactions of hydroxyl radicals can therefore be used to describe oxidations succeeding ozone decomposition.
Source: 5

#1378
Holden, H. "Measurements of air pollution in Prescot." (Presented at the National Society for Clean Air Conference. Folkestone, England. 4 p.) (Nov. 2-5, 1971).

The activities of a Pollution Panel in Prescot, England, which collected data on air pollution inside and outside a factory complex are described. Six monitoring stations were set in schools in a radius of 1 mi from the factory. The students assisted in the continuous monitoring and analysis of sulfur dioxide, solid particles, and metals as copper, cadmium, zinc, and lead. A local brook which passes through a park and acts as a receptacle for industrial waste was surveyed. Mosses were a good indicator of Pb and Cd levels. Data are presented on moss analysis for Pb and Cd in the countryside in London, and in Scotland. Concentrations of Pb were exceptionally high (2314 ppm) in London, compared to 91 ppm in the Scotland countryside.
Source: 1

#1477
Holdgate, M.W., and L.E. Reed. "The fate of pollutants." Inst. of Fuel, London (England), Fuel Environ. Proc. Conf., Eastbourne, England, 1973, p. 113-122, November 26-29, Paper 8.

Sources and sinks of various air pollutants, including sulfur dioxide, sulfates, hydrogen sulfide, carbon monoxide, carbon dioxide, heavy metals such as lead and mercury, nitrogen oxides, hydrocarbons, and photochemical oxi-

dants such as ozone are reviewed from diffusion model and air quality data collected in the United States and Great Britain. A study of major air pollutants and their sources in the United States during the year 1968 indicates that fuel combustion in stationary sources contributed most of the SO_x and a substantial proportion of the particulates and NO_x; while motor vehicles were in the main source of hydrocarbons and CO. Carbon dioxide is the only pollutant known thus far which is accumulating in the atmosphere in a way which may have a global effect, leading to atmospheric warming. Nitrogen oxides, hydrocarbons, and sulfur dioxide exemplify pollutants whose interactions in the air can produce other substances with more serious effects than the original substances, while lead is an example of the type of pollutant which is dispersed widely in the air, settling out to swell background levels in the soil and oceans. Carbon monoxide does not persist for long in the environment and causes concern only where its local concentrations build up to high levels.
Source: 1

#1379
Holobrady, K., and J. Toth. "Beitrag zu den Einwirkungen von festen aus Zementiabriken emitierten Partikelu auf die Vegetation." (The effect of particulate emissions from cement plants on vegetation). Text in German. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p. 139-161 (1968).

The effect of particulate emissions from cement plants was studied in model experiments performed on sugar beet plants grown in glass houses and on field cultures of sugar beet growing in the vicinity of the Stupava cement plant in Slovakia. Ninety percent of the particles emitted were smaller than 10 microns in diameter and contained predominantly calcium oxide, silicon dioxide, and aluminum oxide. The eluate was strongly alkaline. Dust deposits in the glasshouse experiments had a negative effect on organic carbon increase in sugar beet leaves and caused an increase in leaf temperature and a reduction in the size of chloroplasts. The same tests performed on field grown sugar beet did not bear out these results, perhaps because the dust cover is washed off by rain periodically and carried off by wind, and is generally more variable than the dust cover achieved in greenhouse experiments. Thus agricultural crops exposed to particulate emissions from cement plants do not incur appreciable damage, although such damage cannot be excluded completely.
Sourde: 1

#396
Holobrady, K. and J. Toth. "The problem of cement factory dust from the agricultural standpoint." Contemp. Agr., (English translation from Serbo-Croatian of: Savremena Poljoprivredal, 17(7-8):87-96 (1969).

The greatest sources of dust pollution in Czechoslovakia are cement factories with rotary furnaces, discharging almost 100,000 tons of dust into the air annually. Dust discharges have an undesirable effect on the thermal balance of furnaces and, moreover, lower the production of clinker. If es-

caping dust can be trapped, there is the possibility of using it as fertilizer, because of its lime and potassium content. Samples of solid aerosols were obtained by means of passive sedimentation at sites distributed over areas subject to the influence of airborne particles from cement factories. Chemical tests were made using silicate analysis methods and spectrography. the pH factor was measured, and the rate of accumulation of organic carbon was determined. From the agricultural viewpoint, the following compounds obtained from passive sedimentation are of interest: calcium oxide, magnesium oxide, potassium monoxide, sodium monoxide, silicon dioxide, and the trace elements copper, boron, zinc, manganese, and molybdenum. The depression in the accumulation rate of organic carbon after the formation of an even layer of dust demonstrates that solid aerosol particles affect photosynthesis. On an electron microscope photgraph, chloroplasts of dust contaminated leaves have a blurred outline and the tilacoids are difficult to discern. While the action of dust pollution on sugar beet did not affect the yield, it did influence the quality of the beet.
Source: 1

#478

Holub, Zdenek and Olga Kontrisova. "Phytoindikation der Luftverunreinigung durch fluorimmissionen." (Phytoindication of air pollution by fluorine emissions). Biologia, 28(10):827-836 (1973).

A method of leaf analysis for studying the content of toxic substances in plant leaves is described. It can be used to measure areas polluted with fluorine. Analyses of naturally occurring plant species are suitable in regions with higher fluorine content in the atmosphere. Lower concentrations of fluorine in the air are indicated in a more sensible way by the fluorine content of lichens or of plants that have been cultivated in more or less standardized conditions.
Source: 1, 2

#1381

Honda, Hitoshi. "Jumoku no kogai teiko ni kansuru kenkyu. III. Dojo hihai to SO2 teikosei." (Studies on the resistance of trees towards public nuisance. III. The relation between the fertility of soil and resistance for sulfur dioxide gas). Chiba Daigaku Engei Gakubu Gakujutsu Hokoku (Tech. Bull. Fac. Horticulture, Chiba Univ.), 21:91-98 (Dec 1973).

Trees (Zelkova serrata Makino) planted in experimental pots containing different amounts of fertilizer were exposed to 2.5 ppm sulfur dioxide for 2 hr in order to examine the effectiveness of manuring an increasing resistance to SO_2 damage. The manuring was effective in reducing necrosis, decreasing the ratio of defoliation, and enhancing the reproduction of leaves.

The resistivity of street trees to environmental pollution may perhaps also respond to such treatment.
Source: 1

#1380

Honda, H. "Shokubutsu ni yoru taiki osen shihyo ni tsuite." (Air pollution plant indicators). Text in Japanese. In: Investigation of Air and Water Pollution on Human Health. Chiba Prefectural Government (Japan), Dept. of Hygiene, p. 53-65 (May 1973).

Plant growth is governed by natural environmental factors such as weather, climate, and soil and man-made factors of environmental pollution. In the major polluted cities, the effects of air pollution on green plants were investigated. The various manifestations are classified into visible and invisible symptoms and subdivided into chronic and acute symptoms on each part of the plants. Commonly observed symptoms are abnormal defoliation, partial change in leaf color, and various types of necrosis in chloroplast and mesophyll. The branch becomes thinner and shorter, which results in a decrease in leaf number and flowers. The flowering of fragrant olive in metropolitan Tokyo was investigated, and substantial deteriorations in anthesis were observed. The effect of protective planting on the growth of Someiyoshino cherry tree was tested in Hibiya Park. A highly sensitive response to the environment was indicated. The effects on the stem, tree form, and physiological functions were also investigated. Susceptibility to sulfur dioxide was tested using a SO_2 gas chamber. Of 35 species tested, more than half showed a high degree of susceptibility with damaged area index higher than 60%.
Source: 1

#561

Honda, H. "Fundamental study on the influence of plants on air pollution control in the city. III. Dust catching ability of plant foliage. Tech. Bull. Fac. Hortic. Chiba Univ., 22:81-88 (December 1974).

Fundamental study on the planting and space effects in the public nuisance prevention in the city. III Dust catching ability of plant foliage. In order to know the dust catching ability of plant foliage and to select the best species for dust catching in the atmosphere produced from various dust sources, this study was designed to know the covering degree of plant species grown in the natural condition, varying degree of dust catching due to the difference in the covering of plant leaves, and difference in the adherence of dust to the leaves. Dusts selcted for this study were dust (mainly iron oxide) produced from converter in iron-works, sintering mineral dust, and coke dust. Covering degree of 10 species of broad-leaved and coniferous plants was recorded by the measurement of % transmitted light through the foliage at night. To test the dust catching ability of plants, a special apparatus with fan (30 cm in diameter) was made to blow the specific amount of dust to the plants at a constant wind velocity and then, the amount of the dust to be reduced by attaching on the leaves was measured. In the case of 50% covering by Euonymus japonicus foliage, very low catching of the dust by foliage was recorded. In the very high density of the leaves, no difference in the adherent amounts on the leaves was observed, but the lower the foliage density, was the lower dust adherent amounts on the leaves, depending on the kinds of dust tested. Iron oxide dust was caught most easily by leaves, followed by coke dust and sintering dust. The adhesion of dust is considered to be dependent on the difference in particle size, composition and wettability

of the dust. Difference in the dust catching ability of plants may be attributed to the differences in the covering degree of plants, the surface structure of leaves, the easiness of leaf moving and other characteristics specific to the plant species planted. In this study, it was found that over 80% of dust blown to the plants were caught by the foliage of 1 species tested, 50-60% by 6 species and below 35% by 3 species. This result may indicate that triple or double row planting of a single or different plant species having high dust catching ability are needed to catch the various kinds of dust in the atmosphere coming from industries or non-planting places, such as, athletic field, effectively.
Source: 2

#524
Honing, F. W. "Impact of air pollution on the forest resource." Proc. Soil Conserv. Soc. Am. 28:23-26 (1973).

The author writes about the various factors that damage forests - fire, disease, weather, insects. Another primary factor is air pollution. The author discusses the most important air pollutants from non-agricultural sources which are sulfur dioxide, fluoride compounds, and ozone, and he lists minor pollutants as well as those from agricultural sources. The author states that there is a need to develop detection and evaluation procedures for air pollution effects on the forest and he lists five categories of study.
Source: 2

#1853
Honma, S. "Kosaka seirensho shuhen no dojo narabi ni shokubutsu-taichu no kadomiamu ganyuryo ni tsuite." [Cadmium content in the soil and plants in the vicinity of Kosaka Refinery]. Chu-tsu Byoin Iho (Bull. Chu-tsu Hosp.)(Akita), 14(7):73-74 (1973).

The cadmium content in the plants and soil near the Kosaka metal refinery were investigated. The area is in no way polluted by industrial water; it does have air pollution. Within the area of samplings, the soil was polluted up to 6 km upstream from the refinery, and all the samplings taken in the downstream direction contained more than 1 ppm of cadmium. The edible wild plants that are used by the people of the area for food contained from 0.62 to 13.4 ppm of cadmium; of the five specimens, the lily contained the highest concentration of Cd.
Source: 1

#479
Honma, S., K. Nakatani, R. Sato, and H. Kawanobe. "Akita-ken Kosaka-cho ni okeru jukinzoku-to no osen chosa hokokusho." [Report on the investigation of heavy metal pollution in Kosaka Township, Akita Prefecture]. Chu-tsu Byoin Iho (Bull. Chu-tsu Hosp.) (Akita), 14(7):56-72 (1973).

The soil, unpolished rice, and vegetation in two districts of the Kosaka Township, Akita Prefecture were analyzed in December 1971 to see the metal

content. Five g of dry soil and 10 g of dry plants were dissolved by nitric acid and perchloric acid, and the solutions were analyzed by atomic absorption spectrophotometry. Ten g of unpolished rice were dissolved in the same way and extracted by MIBK and atomic absorption spectrophotometry was applied. Cadmium, zinc, lead, copper and manganese were analyzed. High concentrations of Cd, Zn, Pb, and Cu were found in the soil; the highest Cd count downstream was 14.5 ppm. The rice paddies and dry field had apprcximately 7.5 ppm and the mountain soil had 6.9 ppm. Zinc, Pb, and Cu concentration distributions showed the same tendency, with the maximum of 1000 ppm for Zn and Pb. The Mn concentration was higher in the upper stream. In green grass in summer 1000 ppm Cd and 2000 ppm Zn had been found, but the dead grass of winter evidently contains less metals; Cd level was 87.5 ppm and Zn was 539 ppm. Twenty samples of unpolished rice were examined and an average of 0.36 ppm of Cd was found; eight samples had more than 0.4 ppm. The Cd level in small beans was 0.29 ppm, potatoes, 0.59 ppm, celery, 8.5 ppm, and cabbage 0.5 ppm. The Pb and Cu contents were also relatively high in celery.
Source: 1

#480
Honma, Shin, Keitaro Nakatani, Ryoitsu Sato, and Hiroshi Yawata. "Kosakacho 47-nen san genmaichu no jukinzoku ganyuritsu sokutei kekka ni tsuite." (Measurements of heavy metal content in the 1972 crop of unpolished rice in the Kosaka township). Chu-tsu Byoin Iho (Bull. Chu-tsu Hosp.) (Akita), 14(7):80-81 (1973).

The 1972 crop of unpolished rice in Kosaka-cho was examined; the maximum cadmium content among 77 samples was 0.780 ppm, the minimum was 0.068 ppm, and the average was 0.251 ppm. In the Hosokoshi area of the town where the mines are located, the maximum measurement among 37 samples was 0.72 ppm, minimum 120 ppm, and the average was 0.30 ppm. Out of 77 samples, 9 (11.7%) had more than 0.4 ppm in the total area, and out of 37 samples of the Hosokoshi area, 6 samples (16.2%) had more than 0.4 ppm of Cd.
Source: 1

#280
Hooker, M. L., G. A. Peterson, and D. H. Sander. "Ammonia nitrogen losses from simulated plowing of native sods." Soil Sci. Soc. Am. Proc., 37(2): 247-249 (March/April 1973).

The purpose of this research was to measure ammonia gas evolved by volatilization from soils that have recently been broken from the native sod condition. Methodology for measuring NH_3 losses under simulated natural environments is presented. Two moisture levels, field capacity, and wilting point were studied. The NH_3 volatilization was not a significant loss mechanism in the first 160 days after cultivation began.
Source: 1

#1382

Hopkinson, J. M., R. H. Wilson, and B. N. Smith. "Lead levels in plants." Naturwissenschaften (Berlin). 59(9):421-422 (1972).

The use of tetraethyl lead in gasoline has been the major factor responsible for the tremendous rise in atmospheric lead concentrations since the 1920s. As a result, lead contamination has increased along roadsides, in urban areas, and in roadside plants. Plant samples were taken along a highway two miles south of Austin, Texas in August 1970. After drying and ashing, plant samples were analyzed with an atomic absorption spectrophotometer for lead. The levels of lead decreased with increasing distance from the highway. Plants taken 32 m northwest of the road contained less than ½ as much lead as plants adjacent to the road. More lead was found in plants on the northwest side of the road than on the southeast due to prevailing winds. Different species had different capacities to accumulate lead.
Source: 1

#1383

Hopp, H. H. "Experimentelle Untersuchungen ueber Rauchsehaeden an Reben." (Experimental studies on smoke damages in vineyards). Text in German. Die Wein Wiss., 19(5):201-209 (May 1964).

Extensive smoke damage due to fluorine-containing smoke from a nearby waste incinerator plant in two vineyards was reported. Serious necrosis and death of tillers and leaves and corking of grapes were observed. The damage occurred in vineyards previously sprayed with copper-containing fungicide, while untreated vineyards and those treated with dry copper-containing fungicide or another organic fungicide without copper remained largely intact. Fumigation experiments revealed the combination of the fluorine-containing smoke, copper-containing fungicide spray, and low temperature to be responsible for the damage.
Source: 1

#1384

Horak, O. and I. Huber. "Verunreinigung von Pflanzen und Boeden durch Bleiruecksteande aus Benzinmotoren." (Plant and soil pollution by lead residues of petrol engines). Bodenkultur, 25(1):34-47 (Feb 1974).

Lead residues in aerial plant material samples and in soil samples taken at distances of up to 70 m from roads, highways, and airport runways in Austria were determined by atomic absorption spectrometry. The aerial parts of plants contained 3 to 220 ppm lead in the dry matter, depending on the distance from the road. Remnants of dried plants in early spring contained up to 539 ppm lead. The lead content in the plants decreased with the distance from the road first rapidly, then slowly. Up to 54% of the lead could be removed from the plants by washing them with water. Lead emitted by sport planes was detected in some plants close by or on the runways. In soil samples taken near highways and far off the roads, lead concentrations of 27-290 ppm and 12-30 ppm, respectively, were determined.
Source: 1

#1385

Horita, Y. "Kogai seibutsugaku nyumon." (An introduction to pollution and biology. (No. 2)). Text in Japanese. Kagaku to Yakugaku no Kyoshitsu (Chem. Pharm., Quart. J.), 35:21-30 (1972).

The mechanism of photosynthesis, environmental conditions, and the chemical and biological significance of photsynthetic bacteria are discussed. Photosynthetic bacteria, which are extremely useful and important in the ecological system, can become a cause of pollution when excessively proliferated. The idea that pollution could be solved by planting vegetation is also a misconcept. Carbon dioxide is not the major source of pollution, and local increases of CO_2 partial pressure do not affect the environment in general. More important, green plants are sensitive to air pollutants and react faster than any other living things to pollutants such as ethyl, fluorides, nitrate, ozone, peroxyacetyl nitrate, and sulfur dioxide. Only 1-3% of the solar energy is used for photosynthesis. The use must be increased to maximum by effective planning of plant formation, density, and arrangements. Through genetic studies, production and proliferation of useful plants should be planned and developed. Pollution control must be programmed ecologically, most suitable ecological systems must be developed in various geographical areas in addition to the effort to eliminate pollution sources.
Source: 1

#1864

Horntvedt, R. "Virkninger av luftforurensninger pa skog." (Effect of air pollution on forests). Text in Norwegian. Norsk Skogbruk, 17(1):3-4 (1971).

Direct and indirect effects of air pollution and related investigations for a glass fiber plant are described. Direct damage caused by gaseous and particulate pollutants has a local character. Damage to forests was observed around a glass fiber processing plant emitting fluorine and sulfur dioxide in amounts of 3 kg and 20 kg/hr. respectively. Knowledge of meteorological data such as wind speed, stability, and stack height, and emission volume allow correct forecast of concentrations at different distances. The respective thesholds applied for HF and SO_2 were 1 microgram/cu m and 0.5 micrograms/cu m. With neutral stability, HF concentrations exceeding the above threshold could be anticipated at a distance of 5 km in wind direction. Synergetic effects of HF and SO_2, and a minimum exposure time of 10 days were considered. The proliferation of insects and the reduced resistance to drought and frost are some of the indirect effects of air pollution. Increasing soil acidification due to SO_2 is also a general phenomenon. A pH value of 4.7 was measured in 1967 against pH of 5.3 in 1957. The increase in acidity was calculated as 1.5%/yr.
Source: 1

#1725
Horvath, I. "Einfluss von Fluorverbindunger auf die Trockensubstanzproduktion von Buchweizen." (Effect of fluorine compounds on the dry matter production of buckwheat). Text in German. (Presented at the International Symposium of Forest Fume Damage Experts, 7th, Essen, West Germany, Sept. 7-11 1970.) Mitt Forst. Bundesver, 97:335-351 (1972).

The effect of fluorine compounds applied to the soil before sowing, at the start of flowering, and during the ripening of the first fruits was evaluated according to the dry-matter production of Fagopyrum esculentum M (Doxanska variety). The application of fluorine in the rooting medium of the plants at different stages in their ontogeny produced results which indicated that the reduction in dry matter depended, inter alia, on the form in which the fluorine was applied to the soil. Under greenhouse conditions and on standard soil, the maximum inhibiting effect was found with sodium fluoride; the effect was less when fluorine was applied as potassium fluoride or calcium fluoride. In addition, the reduction in dry-matter production was more marked when the individual fluorides were applied before sowing. Increasing the fluorine level in the soil during flowering and during ripening of the first fruits did not cause significant reductions in dry matter, except in the case of sodium fluoride. The maximum inhibiting effect of sodium fluoride occurred when it was applied to the soil at the start of flowering, the effect was less when it was applied before sowing, and was not very significant when it was applied during the ripening of the first fruits. An increase in dry matter and leaf area was observed after a single application of fluorine on the 20th day of growth, indicating that calcium fluoride does not significantly affect the physiological processes of buckwheat during the first 6 weeks after application; the effect of sodium fluoride was quite different. The occurrence of necrotic leaves and the death of the most susceptible individuals were associated with a significant decrease in the formation of leaf surface area and with the reduction of dry matter production. The most resistant individuals, as indicated by the responses to fluorine treatment, equalied or often even surpassed the control plants.
Source: 1

#1386
Hoshino, Tsuneo. "SO2 nodo bunpu kara mita nosakubutsu no damage no suitei." (An estimation of damage by SO2 on crops). Proc. Symp. Japan Soc. Air Pollut., 13th, Paper 189, p. 235 (Nov 7-9, 1972).

Ube and Onoda, industrial and agricultural areas of Yamaguchi Prefecture, have a special pattern of sulfur dioxide concentration. All the high concentration of SO2 in these two cities appear within the radius of 4 km from the emission sources, and there is almost no damaging effect of SO2 on agricultural crops. The geographical distributions of SO2 concentration of 0.1 ppm, which is the threshold for crop damages, and 0.018 ppm, which is the threshold for bryophytes mortality, were examined. The total area with the concentration of 0.018 ppm fluctuated monthly from 3 sq km to 27 sq km, with a mean area of about 20 sq km. The total area with more than 0.1 ppm concentration was relatively

small, and mostly in commercial areas of Onada and Ube, which do not affect agricultural crops anyway. Between March and May, and November and December, there was no area with more than 0.1 ppm of SO2. In February, 8 sq km in Onoda and 4 sq km in Ube had more than 0.1 ppm; from June through October, some 2 sq km in Onoda and 1 sq km in Ube were affected by more than 0.1 ppm SO2. Produce were almost free of any damage from SO2 in those areas.
Source: 1

#1058
Hosker, R. P., Jr. "Estimates of dry deposition and plume depletion over forests and grassland." (Presented at IAEA symposium on the Physical Behavior of Radioactive Contaminants in the Atmosphere, held in Vienna, Austria, November 12-16, 1973).

A standard plume diffusion model, corrected for dry deposition and consequent plume depletion, is applied to hypothetical sources located at several heights above homogeneous stretches of grassland and of forest. The plume is assumed composed of material for which gravitational settling is negligible; this should be typical of many effluents including possible accidental plutonium releases. Only daytime conditions are considered.

Dispersion coefficients and deposition velocities are fairly well established for the open grassland case, and are taken directly from the literature. For a forest, only estimates of these terms can be made. The present estimates attempt to account for the probable effects of the forest on the above-canopy turbulent diffusion and on the effluent deposition velocity, using the recent literature as a guide. Because of the uncertainties implicit in this approach, ranges of values for the necessary terms are utilized.

Downwind distance variation of vegetation-level concentrations and plume depletion fractions are presented for several source heights over a range of possible stability categories and deposition velocities. The relative efficiency of a forest as a remover of effluent material is discussed, and a suggestion is considered that, in cases where concentrations are small enough to avoid biological damage to the trees, a forested region might serve as an effective filter for particulate and gaseous emissions.
Source: 7

#1276
Hosokawa, Y., S. Izumi, M. Chinda, H. Uchiyama, M. Ito, K. Negishi, and K. Takahashi. "Hachinohe chiku no okeru dojo no jukinzoku osen." (On the heavy metal pollution in the soil at Hachinohe area). Aomori-ken Kogai Senta Shoho (Rept. Environ. Pollut. Control Center, Aomori Prefect.), 1: 72-81 (Feb. 1975).

Heavy metal concentrations in the soil of the sea bank industrial area of Hachinohe City were measured on July 30 and July 31, 1973. Soil on the surface no deeper than 10 cm was dried and sieved. For the analysis of mercury, 10-20 g of the sample were heated with a mixture of sulfuric acid and nitric acid and after treatment with urea, potassium permanganate, and hydroxyamine hydrochloride, the Hg concentration was determined by atomic absoprtion. Arsenic

in the sample was analyzed by the colorimetric method with brucine-chloroform after treatment with H_2SO_4-HNO_3-perchloric acid and 1N hydrochloric acid. For the analysis of iron, lead, copper, cadmium zinc and manganese, 5 g of the sample was treated with HNO_3-HC_1O_4 and 1N HC_1, and Fe, Mn, and Zn were analyzed directly by atomic absorption while Pb, Cu, and Cd were extracted with diphenylthiocarbazone-chloroform and then analyzed by atomic absorption. The heavy metal concentrations were significantly higher than those in residential areas and farmlands. The average, FE, Hg, As, Pb, Cu, Cd, Zn, and MN concentrations in the soil of the industrial area were 4.05%, 0.33 ppm, 29.5 ppm, 127.5 ppm, 282.4 ppm, 1.80 ppm, 866 ppm and 891 pppm, respectively. The high concentrations were attributed to the airborne particulates emitted by various plants.
Source: 1

#481
Houston, D.B. "Physiological and genetic response of Pinus strobus L. clones to sulfur dioxide and ozone exposures." Wisconsin Univ., Madison, Thesis, (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 87 p. (1971).

The effects of ozone and sulfur dioxide on eastern white pine (Pinus strobus L.) were studied by fumigating clones from 47 sensitive and 47 tolerant trees during two growing seasons. Exposure of 35 sensitive and 35 tolerant clones to 20 ppm ozone in the first year of the study produced no visible damage on current needles. Studies conducted the following year indicated that SO_2 was the most important factor in the initiation of symptoms characteristic of those noted in the field. All sensitive clones developed symptoms of five pphm SO_2, and all clones, sensitive and tolerant, were damaged at 45 pphm. Concentrations of 2.5 pphm SO_2 plus five pphm O_3 injured current needles on sensitive clones, suggesting a synergistic reaction mechanism for the two fumigants. Ozone trials produced no definite pattern of injury with respect to tolerant and sensitive classes. Repeatability analyses for needle elongation demonstrated that field selection for tolerance and sensitivity can be accomplished with a high degree of success. Biochemical evaluations of phenolic compounds and enzyme systems failed to indicate well defined differences between sensitive and tolerant trees.
Source: 1

#1935
Houston, D.B. and G.R. Stairs. "Genetic control of sulfur dioxide and ozone tolerance in Eastern White Pine." Forest Sci., 19(4):267-271 (Dec 1973).

Clonal repeatability analyses were performed to obtain an estimate of the upper limit of genetic control for tolerance and Eastern White Pine (Pinus strobus) to sulfur dioxide and ozone in greenhouse fumigation chambers. Tolerant and sensitive clones were fumigated for 6 hr with a mixture of 2.5 pphm SO2 and 5 pphm O3, and response was judged by needle elongation and two indices of direct needle damage. Visible injury was defined as tip necrosis and/or distinct necrotic banding. All of the sensitive clones included in the trials were injured, while none of the tolerant clones developed visible symptoms. Differences in needle elongation between clones within tolerant and sensitive groups suggested that tolerance may function

over a wide range of response. Physiological response as characterized by visible damage appeared to operate on the basis of a threshold mechanism, while tolerance of continuing metabolic processes to pollution injury seemed to operate on a more continuous scale. Repeatability estimates based on needle elongation values averaged 0.511; those derived from indices of direct needle damage averaged 0.799 and 0.818.
Source: 1

#1921
Houten, J.G. ten. "De invloed van iuchverontreiniging op planten." (Influence of air pollution on plants). Neth. J. Plants Pathol., 73(4):129 (1967).

The history of plant poisoning from gaseous air pollutants in the Netherlands goes back 60 years; the first incident of this kind was damage caused by fluorine in the vicinity of a superphosphate plant. The effects of hydrogen fluoride, sulfur dioxide, and peroxyacetyl nitrate (PAN) are briefly summarized. Hydrogen fluoride, when present in quantitites as low as a few parts per billion, can cause damage to the leaves of plants. Lichens are so sensitive to sulfur dioxide that they cannot exist in the vicinity of large cities and industrial centers where the SO2 concentration is higher than 35 parts per billion. PAN, sometimes known as photochemical smog, was considered an American phenomenon until October 1965, when abnormal weather conditions in western Europe caused serious damage from this pollutant to spinach and lettuce. Damage to the leaves of certain species and varieties of plants makes them valuable as indicators (their sensitivity exceeding that of the human senses), but they are less accurate than chemical analyses, due to the fact that the 'symptoms' are not entirely specific for higher concentrations. The mechanism of plant damage from air pollutants is not completely understood, although it is known for certain that fluorine, ozone, and PAN act at the level of the cells, functioning as inhibitors of the plant enzymes. Fluorine affects the metabolism of carbohydrates: enolase is especially sensitive to this gas. A combination of PAN and ozone strongly inhibits the synthesis of cellulose. Liquid and solid particles in the air can also cause damage directly or indirectly to plants, especially by limiting the incidence of sunlight.
Source: 1

#805
Houten, J. G. ten. "Invloed van Luchtverontreiniging op Planten." (Influence of air pollution on plants). Text in Dutch. In: Milieubalans van Nederland. J. J. Mulckhuyse (ed.), Amsterdam/Brussels, Intermediair, p. 47-55 (1972).

Theeffects of air pollutants, such as hydrofluoric acid, sulfur dioxide, nitrogen dioxide, peroxyacetyl nitrate, and ozone on plants are surveyed. While there are substantial species-specific differences in the resistance of plants to air pollutants, plants are generally more sensitive to them than animals and humans, except for carbon monoxide and hydrogen sulfide. Thus, it is possible to select certain plant species as indicator plants for pollution monitoring. Necrosis of the leaf edges by HF, and interneural necrosis due to SO_2 were observed. Once retained, SO_2 is readily detoxicated in the leaves by metabolism to sulfates. Peroxyacetyl nitrate and ozone cause zonal necrosis of the leaves probably through the inhibition of the enolase enzyme. Changes in the taxonomic composition of the wild flora in polluted areas were observed.
Source: 1

#1387
Houten, J.G. ten. "Biologische aspecten van de luchtverontreiniging." (Biological aspects of air pollution). Dutch. Chem. Weekblad, 69(26):11-12 (June 1973).

Studies on the effects of air pollutants, such as automotive exhaust components, sulfur dioxide, hydrofluoric acid and ozone, on plants, animals, and humans are reviewed. Very high susceptibility of spinach and lettuce to ozone and peroxyacetyl nitrate was observed. Nitrogen oxides cause leaf burns in certain plants, while nitrogen dioxide interferes with growth processes in tomatoes in concentrations as low as 0.25 ppm. Ethylene in above-normal concentrations has similar effect on tomatoes. Necrosis of leaf tissues due to the action of SO2 was observed. The acidification of the soil and of surface water bodies, a process most acute in Sweden due to SO2 interferes with the livers of certain plant and animal species. Lichens were determined to be most sensitive to SO2 of all plants. Leaf burns and inhibition of the cis-aconitase in Fresid and Gladiolus species due to hydrofluoric acid was evident. This pollutant also tends to reduce bee populations in polluted areas.
Source: 1

#877
Houten, J.G. ten and F. Spierings. "Air pollution and its influence on vegetation." World Health Organization, Copenhagen, Denmark. Proc. Conf. Public Health Aspects Air Pollution Europe, Milan, Italy, 70-75 (Nov 6-14, 1957).

Investigations on the effects of hydrogen fluoride and sulfur dioxide on plants are reported. Fumigation chamber experiments established that the gladiolus variety 'Sneeuwprinses' is extremely susceptible to HF, whereas alfalfa appears to be a useful SO2 indicator. Gladiolus leaf analysis indicated a connection between the intensity of damage and fluorine content, and between these factors in relation to distance from the emitting source. Because of the high sulfur content of alfalfa leaves outside industrial areas, leaf analysis is a useful method for detecting SO2 damage primarily in cases of severe plant injury. Air quality measurements were made in different areas to establish any correlations which chemical leaf analysis. As a result of 110 measurements with SO meters in an area containing SO2 pollution, a daily average of 3-4 mg SO2 was calculated as about the danger limit for plant damage. A monthly total amount of 30-60 ppm fluorine taken up by lime soaked filter paper was the limit at which damage was found on the susceptible gladiolus variety planted next to the measuring point. At 60-120 ppm, slight damage was found on less susceptible crops. Severe smoke damage to fruit trees due to HF was established the adjacent HF apparatus absorbing as much as a monthly total amount of 304 ppm.
Source: 1

#6
Howell, R. K. "Influence of air pollution on quantities of caffeic acid isolated from leaves of Phaseolus vulgaris." Phytopathology, 60(11): 1626-1629 (Nov. 1970).

An investigation was conducted to determine if polluted air containing primarily photochemical oxidants alters phenol metabolism in bean leaves, and to identify and measure O-diphenols in healthy leaves from plants cultured in activated carbon-filtered air and in injured leaves from plants cultured in nonfiltered air. Plant materials underwent paper chromatographic analyses. Primary bean leaves were severely injured by the components of nonfiltered air Total oxidants are suspected to be responsible, since severity of injury paralleled the concentration of total oxidant measured. Fluorsecent compounds were concentrated in the reddish-brown leaves. Caffeic acid concentrations were present in injured leaves at twice the concentration detected in healthy leaves. The presence of elevated levels of caffeic acid could contribute significantly to the biochemistry of the browning reaction noted in oxidant damaged leaves. The actual role of caffeic acid in the development of the symptoms caused by air pollution injury to plants is being studied.
Source: 1

#482
Howell, R.K., and D.F. Kremer. "Ozone injury to soybean cotyledonary leaves." J. Environ. Quality, 1(1):94-97 (Jan.-March 1972).

The relative sensitivity of cotyledons and primary leaves of several soybean cultivars to ozone is described, as well as the chronological age of maximum sensitivity, stomatal response in the presence of ozone, and the extent of ozone injury to the tissue. Cotyledons and primary leaves were most sensitive to ozone six to seven and 13-14 days after seeding, respectively. Injury was similar to that described for leaves of other crops; that is, upper surface necrotic lesions were generally associated with columnar palisade cells. However, if the concentration of ozone is increased or the tissue is exposed for a longer time, some injury can be envisioned on the lower epidermis and a single layer of oval cells adjacent to it.
Source: 1

#483
Howell, R.K., and C.A. Thomas. "Relative tolerances of twelve safflower cultivars to ozone." Plant Disease Reptr., 56(3):195-197 (March 1972).

Safflower cultivars were exposed to ozone under controlled conditions to determine their relative tolerance to the oxidant at concentrations of 25 pphm for 2 hr. Of the twelve varieties tested, Frio was highly tolerant and Nebraska 4051 was least tolerant. The symptoms were generally localized chlorotic to necrotic lesions on upper leaf surfaces, with variations in degree of injury according to susceptibility and tolerance. Sensitive safflower cultivars, therefore, may be used as biological indicators for phytotoxicants.
Source: 1

#1388
Hsieh, S.T., and K. H. Kwan. "Kon chi wu zan twei yen tsau lin tang gi tan suei hua wu tai hsieh yin hsian chi yen chin." (Effects of the air pollution on the metabolism of the sugar phosphates and carbohydrates of tobacco). Text in Chinese. Taiwan Tob. Wine Monop. Bur. Tob. Res. Inst. Ann. Report, 1971: 130-138 (1971).

Ozone injury on the tobacco plants Bel-W-3 (cigar-wrapper tobacco), Bel-B and Vam-Hicks (flue-cured tobacco) was studied in relation to levels of sugar phosphates and carbohydrate metabolism. Experiments with different phosphorus supplies indicated that lower phosphorus levels increased the plants sensitvity to spotting, while higher phosphorus levels significantly decreased leaf spotting. Lesions in the tobacco leaves were caused by ozone, with Bel-W3 being the most susceptible, Vam-Hicks being of moderate susceptibility, and Bel-B being ozone resistant. Bel-W3 appeared useful as a plant indicator for ozone. Exposure of the three tobacco varieties to ozone resulted in dry weight losses of 19%, 15%, and 9% for Bel-W3, Vam-Hicks, and Bel-B, respectively. Ozone injury was associated with levels of sugar phosphates, starch, and total carbohydrates. Leaves containing less sugar phosphates were more susceptible to ozone injury, as were leaves with higher reducing sugars and less starch.
Source: 1

#1389
Huckabee, J.W. "Mosses: sensitive indicators of airborne mercury pollution." Atmos. Environ., 7(7):749-754 (July 1973).

Samples of fly ash, mosses, and other vegetation were selected at varying distances from fly ash sources and analyzed for mercury content in order to determine the applicability of mosses as sensitive monitors of airborne mercury pollution. Fly ash exposed tc rain water collected 2 km from a power plant smokestack had a mean Hg concentration of 0.98 ppm. Based on this value and the annual rate of dry fall, input to the area was calculated to be 20-30 micrograms Hg m to the -2 power y to the -1 power. Mosses had significantly higher Hg concentrations than the other plants collected at the same location, usually by an order of magnitude. The Hg content of mosses appeared to be a function of the distance from smokestacks, ranging from 1.13 ppm in polluted areas to 0.066 ppm in remote areas (mean values). Experiments with radioactive Hg tagged fly ash showed that mosses take up and retain Hg to a greater extent than grasses do.
Source: 1

#1436
Huckabee, J. W., and B. G. Blaylock. "Micorcosm studies on the transfer of HG, CD, SE from terrestrial to aquatic ecosystems." Missouri Univ., Columbia, Environmental Trace Substances Center and National Science Foundation, Washington, D. C., RANN Program, Trace Subst. Environ. Health Proc., Annu. Conf., 8th, Columbia, Mo., p. 219-222 (1974).

Microcosm tanks containing excised stream bank sections, stream sediments, biota, and spring water were used to study the transfer of mercury, cadmium,

and selenium from terrestrial to aquatic ecosystems and to identify target organisms and sinks. Fish (Gambusia affinis) and snails (Goniobasis clavaeformis) were placed in the aquatic portion of the tanks, and a radioactive tracer was applied to the terrestrial portion via simulated rainfall. Labeled mercury from coal fly ash was leachable, with about 50% of the total reaching the aquatic system; more than 99% of the mercury was in the sediments. Fish accumulated more of metal than did snails. Selenium and cadmium transfers from terrestrial to aquatic ecosystems were slow compared to that for mercury. Only about 4% of the initial cadmium was transported to the aquatic portion of the microcosm. Fish assimilated cadmium more slowly than snails. Over 75% of the selenium was retained in the soil with 9% of the metal being found in the sediments. Fish accumulated only 0.007%, about 10 times less than that accumulated by snails.
Source: 1

#1854
Huffman, W.T. "Effects on livestock of air contamination caused by fluoride fumes." Proc. U.S. Tech. Conf., Washington, D.C. 59-63 (May 3-5, 1950).

Fluorine toxicosis in livestock can be caused by aerial contamination of forage with fluorine effluents from nearby industry principally phosphate and aluminum processing plants, although cement plants and enameling works may also be involved. The extent of the area involved is governed by the volume of fluoride effluents, the form in which they occur and meteorologic factors. Effects on livestock depend on the level of intake, duration of the feeding period, the class of animals involved, and feeding and management practices. The symptomatology is described; dental fluorosis and bone lesions are prominent. Normal and threshold levels of fluorine in bone tissue and normal and excess urinary levels are noted. Dairy cattle appear more susceptible to fluorosis than beef breeds, but neither meat nor milk from affected animals is likely to be injurious. Complicating factors unrelated to fluorosis should be considered, since most the symptoms may be present in a variety of diseases. Disease control requires reduction of emissions to the point where nearby forage contains a safe level of fluoride.
Source: 1

#1423
Huntzicker, J. J., S. K. Friedlander, and C. I. Davidson. "Environmental Pathways for automobile emitted lead. Lead from automobile exhaust is traced through the Los Angeles environment." Preprint, California Inst. of Tech., Pasadena, Environmental Engineering Science, 31 p. (1974).

Each day 18 tons of lead are exhausted into the Los Angeles atmosphere by the combustion of leaded gasoline. To understand the implications of this, the environmental pathways for lead are reviewed. Size and concentration of particulate lead depends on the driving mode. Approximately 17.8 + or - 2.6 tons/day lead are exhausted to the atmosphere in the Los Angeles/Orange County area; 17.2 tons/day of this are particles and the rest is in the vapor phase, presumably as tetraethyl lead. Some lead is deposited, depending on particle size. Lead particles on or near roads are those greater than 9 micron in diameter. At 30 m from highways, lead is a factor of 15 less than at the high-

way edge. Results are presented for lead measurements at various distances from highways, in the air in Los Angeles, and in oats. Lead and carbon monoxide in the air are also removed by wind. In measurements in the Los Angeles Basin for 1969 and 1970, the Pb/CO ratio was 0.50 + or - 0.18 micrograms/cu m. Approximately 9800 tons CO are emitted each day in the Los Angeles area. Lead deposition was measured at four sites along the coast and on Santa Catalina Island and San Clemente Island during the summer of 1973. The water surface behaved similarly to the dry surface with respect to particle collection. Deposition values were plotted as a function of distance from the cost, and diffusion of lead to Santa Catalina and Pasadena were measured. Lead input to coastal waters from rainfall was 1.7 tons/day from 1968 to 1973. Runoff and sewage are also sources of lead in coastal water. Lead deposition was measured in remote areas around Los Angeles to determine the transport of wind blown lead. Of the 17.8 tons/day lead exhausted into the Los Angeles area from automobiles, 2/3 is deposited within the basin and 1/3 is blown out of the basin. Most of the lead is deposited on the land and immobilized in the soil, but some street dirt can be washed into the storm sewers and ultimately into the coastal water during the rainy season. Wet and dry season runoff, dry weather deposition, and rainout-washout account for 50% of the input into coastal waters. The reamining airborne lead is primarily in submicron particles which can be transported into remote areas adjoining Los Angeles.
Source: 1

#562
Hurka, H., R. Fuchs, and A. Tress. "Quantitative analsye der flechtenvegetation entlang der geplanten Bodenseeautobahn bei Tubingen." (Qualitative analysis of the lichen vegetation on trees planted alongside the Lake Constance highway near Tubingen, Air Pollution).German. Bot. Jahrb. Syst. Pflanzengesch Pflanzengeogr., 94(3):413-436 (October 30, 1974).

A quantitataive analysis of the bark-inhabiting lichen vegetation, occuring along the Bundesautobahn A 23 to Lake Constance, presently under construction, is undertaken. The investigation serves as a "reference mark" for longterm studies of the effects of exhaust on the structure of the lichen populations. The complex of factors obtaining during this study has been drawn in its generality from the " lines of equal outcome" which are called isoteles.
Source: 2

#103
Hutchinson, G. L., R. J. Millington, and D. B. Peters. "Atmospheric ammonia: absorption by plant leaves." Science, 175(4023):771-772 (Feb. 18 1972).

Ammonia absorption rates for four crop species were measured by monitoring the disappearance of NH3 from an airstream flowing through a small growth chamber containing a single plant seedling. The rates were relatively constant during the day but dropped sharply at night. Daytime absorption rates for sunflower, corn, and cotton plants growing in soil containing 5 mg nitrogen were 4 .9, 5 .6 and 3.5 micrograms sq dm/hr, respectively. For soybeans growing in soil containing 0, 5, and 20 mg nitrogen, the rates were 4.1, 4.2, and 4.0 micrograms/sq dm/hr, respectively. The differences in absorption rates among species may be due to differences in internal leaf geometry, which in turn determines the resistance to diffusive transport of NH3 across the air space inside leaves. The demonstrated capacity of all plants to absorb NH3 suggests an important role for plants in the decontamination of the atmosphere.
Source: 1

#991
Hutchinson, G.L. and F.G. Viets, Jr. "Nitrogen enrichment of surface water By absorption of ammonia volatilized from cattle feedlots." Science, 166(3904): 514-515 (1969).

Appartus designed to measure absorption of ammonia from the air by aqueous surfaces was installed near several cattle feedlots and in appropriate control areas. Ammonia absorption rates measured near feedlots were as much as 20 times greater than near the control. Their magnitudes indicate that absorption of ammonia volatilized from cattle feedlots contributes significantly to the nitrogen enrichment of surface water in the vicinity of feellots.
Source: 5

#1391
Hutchinson, T. C. "The occurrence of lead, cadmium, nickel, vanadium, and chloride in soils and vegetation of Toronto in relation to traffic density." (Presented at the Canadian Botanical Association and the American Institute of Biological Sciences, Joint Meeting, Alberta, June 20-24, 1971.) Preprint, Canadian Botanical Assoc. and American Inst. of Biological Sciences, 27 p. (1971).

From June to August 1970, soil and plant samples were taken at eight sites around Metropolitan Toronto. The sites were selected to give a wide range of traffic density and degree of urbanization. Surface soil, soil from a 2-3 in. depth, and soil from a 5-6 in. depth were collected, and replicate samples were taken at distances from 0 to 30 m from the road edge. Total concentration of lead, cadmium, nickel, vanadium, and chloride in the soils and plant samples were determined. The toxicity of particular metallic salts were determined using root elongation as a bioassay technique. High levels of lead occurred in soils and vegetation in downtown Toronto. The pattern of distribution was clearly indicative of traffic source. Cadmium showed a similar distribution, although at much lower levels. Levels of Pb and Cd in soils were inhibitory to plant growth; laboratory studies showed that Cd and Pb were taken up to a great extent by roots, and that uptake correlated to inhibition. Lead and cadmium levels in trees increased several fold over the last 100 years, and the greatest increase occurred since 1940. Vanadium and nickel accumulated in surface soils with the lowest concentrations at the rural site. Nickel correlated with distance from the highway. The source was anthropogenic. High chloride concentrations near roads were due to road salting operations. Chlorides caused damage to grasses and trees near roads.
Source: 1

#1392
Hutchinson, T. C. "The occurrence of lead, cadmium, nickel, vanadium, and chloride in soils and vegetation of Toronto in relation to traffic density." (Presented at the Ontario Association of Professional Engineers, International Automobile Pollution Conference, Toronto, Ontario, June 1972.) Toronto Univ. (Ontario), Dept. of Botany and Toronto Univ. (Ontario) Inst. for Environmental Studies, Pub-EH-2, 28 p. (June 1972).

During June to August 1970, soil and plant samples were taken at eight sites around Metropolitan Toronto with a wide range of traffic density and degree of urbanization. At each of the sites, three replicate profiles were excavated, cleaned and depth samples taken, and vegetation collected. Total metallic content, lead, cadmium, nickel, and vanadium were measured by atomic spectrophotometry. The toxicity of particular metallic salts was determined using root elongation as a bioassay technique. Radish and tomato seeds were an excellent material for these studies. Chloride levels were also measured, and were up to 1600 ppm in surface soils. A distinct soil profile effect occurred. High levels of lead occurred in both soils and vegetation in downtown Toronto. Concentrations of lead decreased with distance from traffic and had a soil profile distribution characteristic of an airborne source. Cadmium had a similar distribution at lower levels. Lead and cadmium in the soils were inhibitory to plant growth. Lead and cadmium levels in herbarium material from downtown Toronto increased several fold over the past 100 years. Vanadium and nickel increased in surface soils, with the lowest concentrations at the rural site. Nickel correlated with distance from the highway. Chloride levels near the edge of busy streets were high in midsummer, long after the cessation of the winter salting program. Spray carried fine particles away from the road. Soil levels were inhibitory to many plant species and to trees.
Source: 1

#1390
Hutchinson, T. C. "The impact of pollution of the Canadian flora." Toronto Univ., Toronto (Canada), Dept. of Botany and the Inst. of Environmental Sciences and Engineering, Rept. EL-1. (Presented at the Canadian Botanical Association Symposium on the Impact of Man on the Canadian Flora, Western Ontario Univ., June 1973.) 10 p. (October 1973).

The impact of pollution on Canadian flora is reviewed. Reducing smogs, primarily due to a combination of high sulfur dioxide and suspended particulates in a static atmosphere at temperatures from 32-40 F, are a principal factor in the bryophyte and lichen deserts observed in such cities as Montreal. Mining and smelting industries are responsible for SO_2 and heavy metal pollution of the air, water, and soil; and SO_2 damage to eastern white pine is evident up to 15 mi from the nearest smelting source in some cases. Lakes around Sudbury region are heavily contaminated by copper and nickel, both of which kill algae, and the phytoplankton flora is severely depauperated. The effect of lead additives to gasoline is evident in high traffic density areas of cities and along highways were elevated Pb levels in vegetation, soil, and air have been measured. Fluoride emissions from aluminum plants & superphosphate plants also cause phytotoxic situations.
Source: 1

#807
Hutchinson, T. C., and L. M. Whitby. "A study of airborne contamination of vegetation and soils by heavy metals from the Sudbury copper-nickel smelters, Canada." Toronto Univ., Toronto (Canada), Dept. of Botany and the Inst. of Environmental Sciences and Engineering, Rept. EL-3, 17 p. (November 1973).

Soil, vegetation and rainfall samples were collected for heavy metal analysis by atomic absorption spectrometry in an investigation of airborne contamination from copper-nickel smelters in the Sudbury basin region of Canada. Both Cu and Ni showed declining concentrations in soil and vegetation with increasing distance from the smelters. Rainfall was more acidic the closer its proximity to the smelters, with large quantities of Cu, Ni, and iron being present in a pattern of distribution which again pointed to the smelters as a continuing source of metal pollution. Growth of the radicles of tomato and lettuce seedlings in water extracts of soils collected at various distances from a smelter was severely inhibited at distances up to 8 km from the smelter.
Source: 1

#563
Hutchinson, T. C., and L. M. Whitby. "Heavy-metal pollution in the Sudbury mining and smelting region of Canada. I. Soil and vegetation contamination by nickel, copper, and other metals." Environ. Conserv., 1(2):123-132 (Summer 1974).

Soil,vegetation, and rainfall, have been collected in the vicinity of a nickel-copper smelter at Sudbury, Ontario. The region is a major producer of many metals, and the large areas of forest desolation in the vicinity have been ascribed to sulphur dioxide fumigations over the past 80 years. In the present study, attention has been focused on potentially toxic heavy metals. Very elevated soil levels of nickel and copper were found, with values up to 5,104 ppm Ni and 2,892 ppm Cu within 1.1 km of the smelter. The concentrations decreased with distance to 49.8 km in one direction. Surface soils were the most contaminated, and a decline through the soil profile was found. Other metals such as iron, cobalt, and silver showed a similar pattern of distance and depth suggestive of an airborne source. Analysis of the foliage of three plant species also showed excessive levels of nickel and copper as well as of aluminum. The levels declined with distance from the smelter.

The relative possibilities of soil versus aerial uptake are considered. The soils within 2-3 km of the smelter were markedly more acidic than those from farther away, and this was paralleled by their increased conductivity. Dust-fall-rainfall collections and analysis of the soluble heavy metals indicated that a major aerial source of metals existed, and that the problem of metallic emissions is not merely one of the past. Heavy metals are persistent in soils, and the ecological consequences to date have perhaps only been masked around Sudbury by the sulphur dioxide damage, and the particular importance attached to it in the past.
Source: 2

#564
Huttunen, S. "Effects of air pollution on forest vegetation under northern conditions." In: New Concepts in Air Pollution Research, J.O. Willums (ed). 43-53 (1974).

This paper describes briefly some methodological investigations of tree damage caused by air pollution in northern Finland. The methods presented are dendrochronology, applied to the trees of the damaged area, and micro-analysis, applied to demonstrating the presence of sulphur and other pollutants in a biological material. These biological parameters are important in investigating the pollution of air in northern regions, where the cold climate makes nature less resistant than in areas with more favorable conditions. The article also contains some references to the present stage and the future prospects of plant-ecological research.
Source: 2

#1393
Hyogo Prefecture Agricultural Experimental Test Station. "Ozon no tomato ni oyobosu eikyo." (The effects of ozone on tomatoes). Text in Japanese. Hyogo Kenritsu Nogyo Shikejo Gyomu Kotei, 1972 (Annu. Rep. Hyogo Prefect. Agri. Exp. Stn.), 1973:34-37 (1973).

Six species of tomatoes were exposed to ozone to see the level of tolerance and the relationship between the plant sensitivity and system changes. Intermittent exposures were given to tomatoes between September and December in an exposure chamber. The temperature, humidity, and ozone concentration were controlled artificially. With exposures of 0.1 ppm of ozone for 10 hr., no visible signs of damages were noted. With 0.2 ppm of ozone for 5 hr. unopened leaves showed no effect, and young leaves showed relatively little effect. The most sensitive leaves were the most actively growing leaves of medium size. The pore functions and photosynthesis seemed to be affected. Visible dark brown spots appeared. The rate of damages were higher with a short-term exposure to a high concentration ozone than to a long-term exposure at a low concentration. The effects were most diverse at levels between 0.1-0.5 ppm, and slight changes of concentration within the limit affected the degree of damages considerably. With the exposure to 0.2 ppm for 5 hr. the amount of reduction sugar and total sugar increased; the amount decreased with a low concentration exposure. The level of carbohydrate showed a reverse effect.
Source: 1

#1396
Iijima, T. "Kokagaku sumoggu ni yoru nosakumotsu no higai." (Crop injuries due to photochemical smog). Text in Japanese. Kongetsu no Noyaku (Agri. Chem. Mon.), 18(6):35-39 (June 1974).

Crop injuries due to photochemical smog are surveyed. The major constituents of photochemical smog, ozone and peroxyacetyl nitrate, and their major in-

juries on plants are described. Actual damage of major crops such as spinach, Chinese cabbage, kidney beans, soya, okra, maize, taro, welsh onion, crisp head lettuce, and peanuts by ozone and PAN are described. Species specificity in sensitivity to zone and PAN is discussed. Petunia is most sensitive, followed by kidney bean, lettuce, Swiss chard, tomato, Japanese radish, and spinach. Peanut and welsh onion are slightly resistant, and radish is most resistant to PAN. There is varietal specificity in some species of crops, e. g., kidney beans. Identification of oxidant injury is discussed.
Source: 1

1394
Iijima, T. "Sushu nosakumotsu no kokagaku okishidanto shihyosei." (Suitability of several agricultural plants as indices of photochemical oxidants). In: Tokyo Nogyo Shikenjo Sakuho, p. 28-29 (Feb 1974).

Toxic tolerances and thresholds for various plants were investigated in order to select appropriate air pollution indices. Injuries possibly due to air pollution were recognized microscopically on 53 varieties of 25 species of 11 families of plants raised in natural and controlled conditions. Ninety per cent of the injuries were due to oxidants. Spinach, french beans, and swiss chard were susceptible to peroxyacyl nitrate damages. Suitable plant indicators for oxidants,ozone, and PAN were chosen for their high susceptibility to the pollutants, ease of cultivation, and visibility of damages.
Source: 1

#1398

Iijima, T., and S. Motohashi. "Sushu nosakumotsu no okishi-danto shihyosei." (Oxidant indicatory properties of several agricultural crops). Text in Japanese. In: Studies on Tokyo Smog. Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 695-702 (March 1974).

Fifty three varieties of 25 species of agricultural crops belonging to 13 families were cultivated in a greenhouse with a filtered air section and ambient air section and in fields to investigate their oxidant indicator properties. Damages due to oxidant were observed on 20 species belonging to 12 families. The plants which were promising as ozone indicators were radish, kidney bean, lucerne, maize, and taro (Colocasia antiquorum). Swiss chard was promising as peroxyacetyl nitrate indicator. Intervarietal differences in oxidant susceptibility were conspicuous in kidney beans, maizes, and Swiss chards. The position of leaves most susceptible to ozone was 3rd or 4th from the top, and that to PAN was that of the upper leaves (a little younger and still growing). Damage to radish appeared after more than 4 hr. of exposure to more than 8 pphm, after exposure to more than 10 pphm of oxidant, and after exposure for 3 hr at an oxidant dose of more than 30 pphm hr. The damage consisted of bleached spots or white necrotic spots with a threshold value of 7 hr of 8 pphm oxidants with a maximum daily concentration of 15 pphm.
Source: 1

#1397

Iijima, T., S. Sugata, and S. Motohashi. Kokagaku okishidanto ni yoru higai shokubutsu no kogaky kenbikyo ni yoru kansatsu." (Photo-microscopic observation of damaged plants by photochemical oxidants). Text in Japanese. In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 634-639 (March 1974).

The tissues of damaged parts of plants in fields seemingly affected by photochemical oxidants (29 speciesof 17 families), of plants exposed to 15-100 pphm of ozone for 3-90 hr (22 species of 16 families), and of plants exposed to 20 pphm for 9 hr (six species of five families), were examined microscopically. Symptoms such as bleached spots on spinach leaves, which have appeared on 22 species of 13 families of plants in fields were diagnosed as injury by ozone, and the appearance of symptoms and the characteristics of tissue change were reproduced by artificial exposure to ozone on 14 species of plants of 10 families to substantiate this finding. All of the tissues specifically damaged by ozone were palisade parenchyma, and the cellular damages were classified as deformation of cell walls and intercellular coloration, the former being mainly bleached spot and the latter being spots and necrotic spots. The symptoms such as necrotic spots on the lower surface of spinach leaves which have appeared on 4 species of plants of 3 families were diagnosed as injuries due to peroxyacetyl nitrate, and the appearance and specific changes of tissues were reproduced in Swiss chard and kidney bean by artificial PAN exposure. In the case of PAN injury, spongy parenchymatal cells were specifically damaged.
Source: 1

#1395

Iijima, T., S. Sugata, and T. Ohira. "Kokagaku sumoggu ni yoru higai shokubutsu no soshikigakuteki kento." (Histological examination of plant damage by photochemical smog). Text in Japanese. Tokyo-to Kogai Kenkyusho Nenpo (Annu. Rept. Tokyo Met. Res. Inst. Environ. Prot.), 4:105-107 (March 31, 1973).

Plant damage suspected of being caused by photochemical smog was examined by an optical microscope. Twenty-one specimens of damaged plants were compared with 19 specimens exposed to ozone, and the damaged tissues were examined. Among the 15 annuals, brown spots similar in both appearance and structural transformation were reproduced on the ozone-exposed plants. Yellow or white spots on plants had characteristics that were similar to ozone damage. The damage to tao potatoes, petunias, and cauliflowers was quite different from the ozone damage. On perennials, similar damage was reproduced by the ozone exposure. The damage on 15 specimens was judged to be ozone damage. With few exceptions, all the special damage was in the palisade tissues of the leaves. The cell damage could be classified into the deformation of cells walls and discoloration of cells. The former manifested itself as white spots and the latter as mottling and necrosis.
Source: 1

#395

Il'kun, G. M., V. V. Pankrat'yev, S. A. Tarasenko, A. S. Mironova, and L. A. Mikhaylenko. "Puti povysheniya gazostoykosti rasteniy." [Means of increasing the resistance of plants to gases]. Puti Povysh, Intensiv. Prod. Fotosin., 2:124-133 (1967).

Plants (black locust, petiolate elm, Norway maple, narrow-leaved oleaster, Scotch pine, red-veined poplar, common ash, dog rose, apricot, walnut, mulberry, English oak, Chinese poplar, white mulberry, and horse chestnut) were fumigated with 0.00015% sulfur dioxide or 0.00005% chlorine. Uptake of sulfur and chlorine by the leaves was determined; accumulation ranged from 1.0 to 2.25% for chlorine and 0.21-1.03% for sulfur (as compared to 0.1-0.5 and 0.2-0.9%, respectively, in controls). Exposed plants exhibited reduced photosynthesis, and most underwent weak acidification of protoplasm and slight increase in oxidation-reduction potential. Catalase, peroxidase, and polyphenoloxidase activity were generally reduced in exposed plants. In general, plants resistant to saline soils are also resistant to these gases, and studies with seedlings showed that addition of 0.1% water solutions of sulfuric and hydrochloric acid enhanced plant resistance to the corresponding gases.
Source: 1

#8

Il'kun , G. M., V. V. Pankrat'yev, S. A. Tarasenko, A. S. Meronova, and L. A. Mikhaylenko. "Ways of increasing the gas resistance of plants." Puti povysheniya internsionorti prod. fotorion, No. 2. pp. 124-233. (1967).

Briefly reviews the physiological effect of toxic gases on plants. Fumigated plants with SO_2 and chlorine. Found that physical injury of plant was related to amount of toxic element absorbed per unit time. Concluded that degree of injury during short-term gassing depends on relative rather than abiolute increment of the toxic element.Fumigated plants undergo a decrease in photosynthetic intensity and an increase in intensity of respiration. Found resistance of plant to damage from chlorine and SO_2 could be increased by raising plants under conditions of increased salt concentrations of these two elements. Suggests that plants be thus conditioned before planting in areas of high concentrations of these pollutants.
Source: 8

#1399

Illinois Univ. at Urbana-Champaign, Urbana, Environmental Studies Program. "Environmental pollution by lead and other metals (progress report)." National Science Foundation IRRPOS Grant GI-26, RANN Grant GI-31605, Rept. NSF/RA/E-72-001, 462 p. (May 1972). NTIS:PB-222824.

A progress report of interdisciplinary research conducted by a number of groups to develop an understanding of the movement and effect of lead and other trace metals in the environment so that decisions regarding control of these possible pollutants might be made more rationally is presented. The total ecosystem group has obtained preliminary data on lead inputs, out-

puts, and other system fluxes. Background information on lead concentrations and biomass of plants, animals, and the aquatic community has also been collected. The air-soil-water-plant continuum group has found that lead halide aerosols generated from controlled temperature melts were significantly more stable than lead halides in automobile exhaust. Studies of soils revealed significant accumulations in roadside areas. Plant and animal uptake studies indicate appreciable uptake of lead and cadmium. Net photosynthesis, transpiration, and respiration are decreased by lead and cadmium. The animal processes group studied lead interactions with a target organ tissue, the red blood cell membrane, lead influences on the metabolic pathway leading to heme synthesis, and lead accumulations in, and disappearance from, mammalian tissues. The modeling team has concentrated on total ecosystem transport modeling, plant and animal uptake, distribution modeling, and economic systems modeling.
Source: 1

#1450

Ilmurzynski, E. "Attempt of the introduction of certain North American tree species to forest plantations in industrial regions." Polska Adademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 415-425 (1968).

Cultures (0.28 ha in size) of white pine, red oak, Douglas fir, northern white cedar, and eastern hemlock of North American origin were planted experimentally in many localities of Poland including the Upper Silesian, Dabrowa, and Krakow industrial basins to study the effect of various biotic and abiotic environmental factors including air pollution, pest infestation, and fungus diseases. Results obtained over a four-year observation period were encouraging with respect to the possibility of using some American tree species to replace susceptible domestic species which cannot withstand the effects of pollution in industrial areas. The relatively good health of white pine stands surrounded by dying domestic Scots pine trees was a case in point. Insect infestation was lower than in domestic species and the rapid healing of wounds caused by the Hylobius beetle demonstrated the superior regenerative power of the white cedar. Results obtained previously with the western red cedar and the western hemlock were also promising.
Source: 1

#1401

Imaizumi, S. "Tabako no ha no ozon shogai to kiko to no kankei ni tsuite." (Relation between ozone injury and stomatal behavior of tobacco leaves). Text in Japanese. Hatano Tabako Shikenjo Hokoku (Bull. Hatano Tob. Exp. Stn.,), 73(3):17-22 (March 1973).

Direct microscopic observation techniques were used to investigate the relation between stomatal behavior of tobacco leaves and ozone injury. Stomatal apertures of ozone-susceptible tobacco varieties were wider than those observed in resistant varieties, with the extent of ozone injury paralleling the degree of stomatal aperture. Young and small stomata, such as those found on the upper portion of leaves, showed rapid response to ozone, while older and larger stomata showed resistance to closing. Stomatal responses were slow when the leaves were treated with low concentrations of ozone; high concentrations of ozone resulted in the development of irreversible dehydration symptoms regardless of stomatal aperture.
Source: 1

#1402

Impens, R. "Effets des Polluants Gazeux sur les Vegetaux: L. aphydride Sulfureux." (Effects of gaseous pollutants on plants: sulfur dioxide). Translated from French. Scientific Translation Service, Santa Barbara, Calif., 19 p. Ann. Gembloux, 77:147-161 (1971).

The effects of gaseous pollutants on vegetation are discussed. Plant injuries, the general result of the physiological and pathological response of the plant, and the plant damage, corresponding to the economic and aesthetic effects of air pollutions are distinguished between in the three categories of disturbances; acute, chronic, and invisible harm. The harmfulness of pollutants appears principally at the cellular level. Changes in anabolism and catabolism, inactivation of enzymes, or alteration of pigments related to pH changes can be noted. As effects accumulate, there is an appreciable decrease in plant growth. Observation and experimental methods used to determine the effect of gaseous pollutants, as sulfur dioxide, consist of four phases: observations of the behavior of plants, including symptomatology, the influence of the plant's age and stage of development on the mode of action of SO_2, specific plant resistance and microscopic studies of the effects of SO_2; air analysis to determine the precise SO_2 content of air; the measurement of physiological perturbations by chemical, biochemical, and phsiological analyses; and the investigation of indicator plants. All four phases are discussed in detail. Source: 1

#1403

Impens, R. "Effet sur la vegetation d une pollution accidentelle dan la region d Engis." (The effect of an accidental pollution episode on the vegetation in the engis region). Ann. Mines Belg., 10:1157-1165 (October 1973).

An episode of accidental air pollution due to the abrupt release of large quantities of sulfur dioxide from a sulfuric acid production plant in Engis in the Meuse Valley in Belgium, and the effects of the high SO_2 concentrations on the vegetation in the surroundings are described. The pollution episode, associated with fog, lasted Sept. 5 to 6, 1972. The SO_2 concentrations measured during the pollution episode at distances of up to 6000 m were in a range of 204-1067 micrograms/cu m. Considerable damages due to the high SO_2 concentrations were observed. The damages manifested themselves in defoliation: interneural, apical, or marginal necroses: chlorosis, and malformations of the leaves. Allim porrum, Avena sativa, Arrhenaterum elatius, Betula verrucosa, Carpinus betulus, Cichori m endivium, Fragaria vesca, Lactuca sativa, Malus communis, Medicago sativa, Mercuralis annua., Stellaria media, and Trifolium spp. were among the most sensitive species while such species as Buxus sempervivus, Chamecyparis spp., Clematis spp., Cratagus oxycantha, Ilex aquifolium, Ligustrum spp., Prunus laurocerasi, Robinia pseudoacacia, and Zea mays were fairly resistant to SO_2. Acer spp., Allium cepa, Brassica spp., Cornus sanguinea, Dahlia spp., Fraxinus excelsior, Gladiolus spp., Larix europea, Petroselinum sativum, Pinus spp., Populus spp., Quercus pedonculatus, Rosa spp., and Tha platiphyllos assumed an intermediary position between the sensitive and resistant species. Source: 1

#1404

Impens, R.Z., M Vunzu, and P. Nangniot. "Determination du plomb sur les vegetaux croissant en bordure des autoroutes." (Determination of lead on plants growing alongside highways). Proc. Int. Symp., Environ. Health Aspects Lead, Amsterdam, Netherlands, 135-143 (May 1973).

During the summer of 1971, vegetation and soil samples were taken along motorways and from a control zone, and their lead was measured by means of an imposed voltage oscillopolarographic technique. The Pb concentrations varied according to the traffic density, the degree of proximity, the orientation relative to the prevailing winds, and the type of vegetation. The results reveal a high risk of Pb contamination of fodder and of certain green vegetables growing near (0-35 m) to the highway.
Source: 1

#10

Ingersoll, R. B. "Soil as a sink for atmospheric carbon monoxide." (Final report). Stanford Research Inst., Menlo Park. Coordinating Research Council Contract CAPA-4-68 (1-69), and SCU-8799, Environmental Protection Agency Rept. APTD-1307. 45 p. (October 1971).

Soils and vegetation as a sink for atmospheric carbon monoxide were investigated. Higher plants tested had no detectable capacity for decreasing CO levels. Soils from a wide range of ecotypes depleted CO from atmospheres above them at rates averaging 8.44 mg/hr/sq m of soil surface, indicating that soils could be a major sink for atmospheric CO. The depletion of CO by soils was sensitive to temperature, with a maximum depletion rate at 30 C and a temperature coefficient of 3-6. Soils sterilized by steam, antibiotics, or salt lost the capacity. Anaerobic conditions totally inhibited the process, and there was a slight specificity for a depletion of the lighter isotopes of CO. Constant and prolonged exposure of soil to CO reduced the microflora population and the soil's capacity to deplete CO. Among the bacteria and fungi isolated from the soils, 14 fungi possessed the capacity in pure culture to deplete CO. Preliminary experiments with carbon-14 labelled CO indicated that soils oxidize CO to carbon dioxide.
Source: 1

#1275

Ingersoll, R. B. "The capacity of the soil as a natural sink for carbon monoxide." (Final Report) Stanford Research Inst. Menlo Park. Coordinating Research Council Contract CAPA-4-68 (1-71). Environmental Protection Agency Contract 68-02-0307, SRI Proj. LSU-1380, Rept. EPA-650/2-73-043. 41 p. (December 1972).

Field studies in which soils were exposed in situ to experimental atmospheres containing carbon monoxide were performed to determine the potential magnitude of North American soils in serving as a sink for atmospheric CO. The uptake of CO by the soils was highly variable, with rates ranging from 7.5-109.0 mg CO/hr/sq m. Tropical soils were generally the most active and desert soils the least active in CO uptake; forest soils were generally more

active than grassland soils. Carbon monoxide uptake was greatest at a concentration of 100 ppm and decreased as the concentration decreased. This effect was most pronounced for soils with the slowest uptake rates. Rate of CO uptake by soils under cultivation was significantly less than that of the same soil under natural vegetation, probably a result of a lack of organic matter in the cultivated soils. The uptake rate of soils adjacent to a major highway was greater for soils with a dense surface cover of vegetation than for bare soils. Laboratory studies indicated that soils constantly exposed to high levels of CO had a greater CO uptake rate. Carbon monoxide uptake potentials for soils in the United States and the world were estimated to be 505 million and 14.3 billion tons/yr. respectively.
Source: 1,5

#394

Inman, R. E., and R. B. Ingersoll. "Note on the uptake of carbon monoxide by soil fungi." (Presented at the Air Pollution Control Association, Annual Meeting, 64th. Atlantic City. June 1971. Paper 71-65). J. Air Pollution Control Assoc. 21(10) :646-647 (October 1971)

When the chemical and photochemical reactions known to transform carbon monoxide in the atmosphere were recognized as being too slow to account for the disappearance of the quantities of CO in question, first green plants and then soil were investigated as possible sinks for CO. None of the green plants tested demonstrated any tendency to take CO out of the atmosphere, nor did sterile soils. Potting soil, however, had a distinct capacity for CO uptake, and a series of testsstrongly indicated that the uptake of CO was mediated by a biological rather than a physical mechanism. When isolations of microorganisms were made from three of the soils collected in California, of the 200-plus cultures tested, 16 proved capable of removing atmospheric CO. All were fungi.
Source: 1, 6

#572

Inman, R. E., and R. B. Ingersoll. "The soil as a natural sink for carbon monoxide." Preprint, Air Pollution Control Assoc., Pittsburgh, Pa. 5 p. (1971). (Presented at the Air Pollution Control Association, Annual Meeting, 64th. Atlantic City. June 27-July 2, 1971. Paper 71-65.

The chemical and photochemical reactions known to transform carbon monoxide in the atmosphere were recognized as being slow to account for the disappearance of the quantity of CO in question. Green plants were known to remove carbon monoxide from the atmosphere, but when exposed in a test chamber to CO, none showed any capability whatsover to remove CO from the air. The species tested included knobcone pine, two mimosa species, pigweed, curlydock, corn, barley, cotton, cucumber, dwarf tom thumb, and three species of desert annuals. However, when soils were investigated as a possible sink for CO, concentrations dropped from over 120 ppm to zero within a three hour period. The soils with the highest uptake activity were usually those with the higher organic content and lower pH. Additional tests were undertaken to determine the effect of soil temperature, sodium chloride added to the soil, and the addition of antibiotics. Failure of the mechanism under anaerobic conditions indicates that at least in the potting soil, aerobic microorganisms alone are responsible. Cultures revealed four strains of fungi to be present.
Source: 1

#82
Inman, R. E., R. B. Ingersoll, and E. A. Levy. "Soil: a natural sink for carbon monoxide." Science, 172:1229-1231 (1971).

A potting soil mixture depleted carbon monoxide in a test atmosphere from a concentration of 120 parts per million to near zero within 3 hours. Maximum activity occurred at 30°C. Steam sterilization of the soil, the addition of antibiotics or 10 percent (by weight) saline solution, and anaerobic conditions all prevented carbon monoxide uptake. Sterilized soil inoculated with nonsterile soil acquired activity with time. Samples of various natural soils differed in their ability to remove carbon monoxide from the air. Acidic soils with a high content of organic matter were generally the most active. The soil's ability to remove carbon monoxide from the atmosphere is ascribed to the activity of soil microorganisms.
Source: 6, 7

#1492
Inoue, E. "On the turbulent structure of airflow within plant canopies." J. Meteorol. Soc. (Japan), 41:317-378 (1963)

Taking the observational evidences of the exponential wind velocity profile within crop canopies into account, the geometrical and dynamical characteristics of canopy-eddies have been investigated from both theoretical and observational points of view. The length, width and depth of canopy-eddy have been suggested to be constant with height within the canopy layer and to be in proportion to (H-d), where H is the crop height and d the zero-plane displacement derived from the logarithmic velocity profile above canopies.

Velocities in three directions of canopy-eddy are also suggested to decrease downward following the exponential form of exp (-a(1-Z/H)), where Z is the height measured from the ground surface beneath the crop height plane.

The connections between the exponential and the logarithmic velocity profile within and above crop canopies and those between the canopy-eddy and the Honami-eddy, which causes waving-plants phenomena (Honami), are specifically dealt with.

Applying the inertial-subrange theory of turbulence to canopy-eddies a method of evaluating the vertical transfer coefficient within crop canopies is presented and tested with earlier observations.
Source: 5

#202
Inoue, E. "On the CO2-Concentration profiles within crop canopies." J. Agr. Meteorol. (Tokyo), 20(4):137-140 (March 1965).

The build-up mechanism of CO2 concentration profiles within crop canopies is theoretically dealt with, taking into account the absorption and/or liberation of CO2 due to photosynthetic and/or respiratory activity of plant communities. The CO2 budget equation is given.
Source: 1

#1405

Inoue, Takao. "Aryusan-gasu ni yoru junioku no higai." (Damage to trees by SO2 gas). Shokubutsu Poeki (Plant Prot.), 27(6):224-228 (June 1973).

Sulfur dioxide is the major pollutant which causes damage to green trees. Tree damage also occurs in industrial and residential areas where complicated pollution consisting of hydrogen fluoride, chlorine, nitrogen oxides, carbon monoxide, hydrocarbons, dusts, and oxidants occurs. The local effects of SO2 on plants was studied in Japan. Studies included effects of SO2, susceptibility of tree species, relationship between susceptibility and amount of sulfur accumulated and experiments on actually planted trees. Specific susceptibility was noticeable in common trees such as cedar, Momi fir, red pine, cypress, and cherry trees. Damage to zelkova trees was conspicuous with discolored leaves and abnormal defoliation. Symptoms were related to growth stage, season, and soil moisture. The sulfur content of leaves damaged by SO2 was larger than that of healthy trees; the rate of sulfur accumulation was largest in red pines; Japanese cedars, and cypresses. Theories of the mechanism of damage are discussed. Damage was greater as the SO2 concentration increased in the air and in the leaves.
Source: 1

#1930

Inoue, T., H. Ohno, and Y. Doi. "Taiki osen ni yoru jumoku higaijidosha haiki gasu no higai." (Responses of trees to air pollution). Text in Japanese. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, Tokyo, Japan, 1970) Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1): 157 (1970).

The effects of automobile exhaust gas on red pine, cherry, and zelkova tree seedlings was observed in special glass chambers for a period of 48 hrs (six hours a day for eight consecutive days) during June and July. Exhaust gas, diluted by factors of 10, 100, and 500 was emitted from an automobile with 1200 cc exhaust capacity. The engine was rotated at 800/min at all times, and the same type fuel was used for all the experiments. The test material in control chambers continuously received fresh air. The temperature of all chambers was kept at 28 C during the day and 20 C at night. Red pine did not manifest a notable effect, but the tips of some young leaves were dehydrated and curled up in the chamber of 10% and one percent dilution. The tips of some young leaves of the cherry were somewhat discolored, and some mature leaves had brown spots. The edges of zelkova leaves in 10% dilution turned brown and dropped out several days after the completion of the test. No visible change was detected in the chambers of one percent and 0.2% dilution, but young leaves withered. Water content in the leaves of red pine and cherry showed no special change, but the red pine leaves showed difficulty in stomata function. The trees manifested a relatively low sensitivity to exhaust gas in spite of the high concentration. No clear cut results were obtained outside the minor changes on cherry and zelkova in the 10% gas. However, a biological change of trees in relation to water content was detected.
Source: 1

#1407

Institut National de la Recherche Agronomique Paris, Bordeaux (Paris), Lab for the Study of Atmospheric Pollution. "Effect of SO_2 on Wheat." Sulphur Inst. J., 8(3):8 (1972).

A series of experiments were carried out to determine what the effect of accidental exposures of sulfur dioxide would be on a wheat crop. In a wheat field, a number of light plastic airtight tents were set out, and measured amounts of SO_2 injected into the tents. On individual plots, the SO_2 treatment was carried out at different stages of growth: sprouting, tillering, flowering, and all three stages. The SO_2 treatment lasted for 30 min, the gas being injected in six equal amounts at 5-min intervals to give the determined concentrations. Results at harvest time indicated that the height of the plants and the number of heads were not significantly affected by any of the treatments. Only under the most severe conditions were the yields affected. Necrosis was evident in all treatments and at all concentrations. Treatment at all three growth stages with 189 ppm SO2 resulted in a 40% reduction in 1000 grain weight and a 20% reduction in specific weight.
Source: 1

#1406

Inst. for Policy Sciences (Japan). "Sangyo katsudo to shizen to no chowa no tame no ekoroji shisutemu e no sekkin." (Progress toward an ecology system designed to harmonize industrial activities and nature). Text in Japanese. 509 p. (March 1972).

Sulfur dioxide emitted mostly from factories is believed to be responsible for most of the plant injuries. Although there are differences of the resistances toward this particular gas, most of the plants die in a few hours after being exposed to 0.4 to several ppm of sulfur dioxide. The injured plants generally show gray or brown spots on veins of leaves which eventually fall. The SO_2, when washed by rain into soil, reacts with calcium and consumes the nutrients. Carbon monoxide and hydrocarbons of low molecular weight cause the destruction of chlorophyll and the abnormal falling of leaves. Other air pollutants that inhibit the growth and damage the plants include nitrogen oxides, smog, hydrogen fluoride, chlorine, hydrogen chloride, and airborne particulates.
Source: 1

#485

Ionescu, A., and E. Grou. "Aspects of the physiology and biochemistry of some plants existing under the influence of atmosphere pollution." Rev. Roum. Biol. Ser. Bot., 16(4):263-271 (1971).

Vegetation of the Copsa Mica zone in Rumania is often visibly affected by noxious elements existing in the atmosphere, in particular by sulfur dioxide. Comparative investigations were undertaken of some physiological and biochemical processes in different culture plants and flora, both in polluted zones and in control zones. Water content, stomata condition, and hydrogen ion concentration in cellular sap were analyzed. Modifications occurred to plants in the polluted zones which were sometimes substantial. A foliar symptomatology and a chromatogram of free amino acids different from that of the controls were obtained in Pelargonium plants exposed to an experimental atmosphere of SO_2.
Source: 1

#484
Ionescu, A., V. Sanda, E. Grou, and I. Buiculescu. "Considerations of the effects of atmosphere impurification upon the flora and vegetation of the Copsa Mica region." Rev. Roum. Biol. Ser. Bot., 16(2):125-139 (1971).

Atmospheric pollution can cause disturbances in vegetation eocsystems and cause damage to the flora of industrial areas. The general condition of plants was surveyed in the Prostita-Copsa Mica area where two sulfuric acid, one non-ferrous, and one carbon black factories are situated. Transpiration was more intense in plants growing in control zones than in polluted areas. Sulfur dioxide, emitted from a non-ferrous metal factory, converted to sulfuric acid on contact with moisture. The acid caused chlorosis and defoliation on some plants. However, other species thrived well, even near sulfuric acid plants. Vines and orchards on the area of the Prostita hill most severely subjected to SO_2, have been mostly destroyed. The combined effect of carbon black and SO_2 was more powerful than that produced by each element separately. Biochemical transformations of amino acids and proteins were determined in the polluted area. Plant growth, development, and agricultural production were surveyed to determine species sensitivity.
Source: 1

#808
Ionescu, A., G. Serbanescu, and G. Pal. "Elements of the symptomatology of fluor polluted plants." Rev. Roum. Biol. Ser. Bot., 17(2):135-144 (1972).

The toxic effects of fluorine compounds on plants was studied near aluminum and phosphate fertilizer factories. The general condition of the vegetation in the polluted area, necrosis and foliar and floral discolorations, and sterility in some plant species are discussed. Physiological analyses concerning functional stomata, cellular sap concentration, and biometry were used to explain the fluorine intoxication process. They also constituted an indicative test of the degree of pollution. Symptoms of injury can be used to determine thresholds and tolerance levels for fluoride injuries.
Source: 1

#1408
Ishikawa, Haruhiko. "Taiki osen busshitsu ga shokubutsu ni oyobosu eikyo." (The effects of air pollutants on plants). Denryoku Chuo Kenkyusho-ho (Central Res. Inst. Elec. Power Ind.), 21:6-10 (1972).

Various factors for the appearance of plant damages by sulfur dixoide were studied by grape leaf experiments. When a continuous exposure and a sporadic exposure were compared, the sporadic method of exposure caused remarkably less damage. For instance, when exposed to 0.26 ppm of SO2 continuously, the grape leaves showed the damage in 24 hours; but when they were exposed only

during the day, damages appeared only after 14 days. The stage of growth and season have an important relationship with the damages by air pollutant. The perennials such as fruit trees are easily damaged between summer and fall, and most resistant in winter. The SO2 absorption by plants during the day is about twice as much as that during the night, and plants are more easily damaged as the daytime exposure to SO2. When the plant is healthy and in good condition, air pollution damages can be avoided to a certain extent. The amount of fertilizer and plant care can also contribute. With regard to meteorological conditions, strong sunshine, high temperature, or humidity damages plants easily. Reddish lights damage plants more than bluish lights. Generally, damages do not appear on cloudy or rainy days but mostly appear during early morning hours on sunny days. When humidity is high and the sunshine suddenly increases after the rain, plants are more susceptible to air pollutants. When pesticides and SO2 multiply their reactions, fruit trees and small plants can be damaged by free copper ions, especially when the weather is wet.
Source: 1

#283

Ishizaka, Y. "On materials of solid particles contained in snow and rain water: Part I." J. Meteorol. Soc. Japan, 50(4):362-375 (Aug. 1972).

Snow and rain water samples were collected at a site on the coast of the Hokuriku district in February and March 1970 and rain water samples were collected at a site on Mt. Odaigahara in July 1970. Solid particles contained in snow and rain water samples were analyzed by means of X-ray, infrared, and electron optical methods. Most of the solid particles in snow samples were found to be soil particles originating from the arid or semi-arid regions of North China and Mongolia; these soil particles are considered to play an important role as ice nuclei in the formation of snow crystals in the season of northwest monsoon. At both sites, rain water samples precipitated from the air mass which did not pass through the arid or semi-arid regions of the continent of Asia and stayed over the ocean for a long time contained a small quantity of solid particles. Rain water samples collected from rainfall due to Typhoon 7002 contained a very small quantity of solid particles, which were identified as alpha-quartz, alpha-cristobalite, pyroxene, and an unidentified mineral. These particles may be of volcanic and other origins and may be suspended in the upper troposphere and stratosphere.
Source: 1

#1409

Iwamura, Y. "Jumoku-so no kogai gensho to taiki osen tono kanren ni tsuiteno kenkyu." (A study on the relationship between plant damage and air pollution). Aomori-ken Ringo Shikenjo Hokoku (Amori Apple Exp. Stn.), 1973:89-91 (Sept 1973).

The effects of calcium hydroxide dust emitted from a shipping yard on the black pine tree woods west of the industrial area are investigated. The wind was strong throughout the year, predominating from the west. The leaves of black pine trees were collected from 14 points and from 20 areas of underbrush. The amount of adhered dust, electric conductivity, and pH of washings were examined. The amounts of adhered dust were largest in the leaves nearest the origin of the pollutant, and there was a tendency of decrease with the increase of distance from the source. The pH showed the same tendency. Electric conductivity was affected by the pollutant in places near the source; however, in some remote places the effect seemed to be due to sea-breezes.
Source: 1

#1410
Izumida, S., and M. Saeki. "Sendai-shi shuhen ni okeru chii-rui to taiki osen tono kanren ni tsuite." (On the relationship between lichens and air pollution in and around Sendai City). Text in Japanese. (Presented at the Japanese Society of Public Health Annual Meeting, 33rd, Fukushima, Japan, Oct. 16-18, 1974, Paper 544.) Nippon Koshu Eisei Zasshi (Japan J. Public Health) 21(10):414 (October 1974).

All species of lichens which have grown on the tombstones in public cemeteries within a radius of 10 km in the center of urban Sendai were identified and the distribution of the lichen species was mapped. The ratio of the area of lichen growth vs the number of tombstones on which lichen could grow was ranked into five levels and these indexes were also mapped,the species being Parmelia tinctorum, Parmelia caperata, Parmelia clavulifera, Parmelia reticulata. In another series of investigations, four lichen species growing ing on more than 5 sq m of the surface of black pine in areas 1,2, 3, 4, 5, 6 and 7 km from a power station in the Sendai port were determined. Of the original 31 species, one type showed a distribution quite similar to that of sulfur dioxide in air; another type showed a reverse distribution to that of SO_2, and still another type showed no reaction to air pollution. The four species above mentioned did not grow in the city parts of Sendai and Shiogama. When the growth was ranked into five levels, the distribution of the ranks coincided well with the distribution of SO_2 in air. No lichens of the above mentioned species were found in the area where SO_2 concentration in air was larger than 0.018 ppm.
Source: 1

#809
Jacobson, J. S. "The plant-mediated consequences of air pollution." Colorado Univ., Boulder, Air Water Pollut.Proc. Summer Workshop, Boulder, Colo., 1970, p. 417-424 (August 3-15, 1972).

The effects of air pollution on plants and vegetation are discussed. The most serious threats to vegetation in North America are from photochemical oxidants (ozone and peroxyacetyl nitrate), fluorides, and sulfur dioxide. Injury to plants by other pollutants as ethylene, nitrogen dioxide, chlorine, hydrochloric acid, and particulate matter play a more limtied role. Tobacco plants are widely used as a biological indicator of O_3 because leaves exhibit flecking when exposed to O_3. Parts per billion concentrations of fluoride in air can cause severe damage to sensitive vegetation. Large areas of land are still contaminated by sulfur oxides resulting from pollution from smelters in existence 70 yr ago.
Source: 1

#565

Jacobson, J. S., and W. A. Feder. "A regional network for environmental monitoring: atmospheric oxidant concentrations and foliar injury to tobacco indicator plant in the eastern United States." Massachusetts Agricultural Experiment Station, Res Bull Univ Mass Amherst Coll Agric Exp Stn 60 31p., May 1974.

Northeast Regional Project 56 (NE-56) began in 1966 and functioned until 1972 in nine States: Maine, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, and North Carolina. The first Administrative Advisor was Dr. James G. Horsfall, Director of the Connecticut Agricultural Experiment Station. The project was continued under Dr. A. A. Spielman and was completed with Dr. W. J. Mellen as Advisor. The project was titled: "Air Pollution Problems in the Northeast" and its over-all aim was to study the impact of air contaminants on agriculture. Photochemical oxidants were selected as the group of pollutants with the greatest potential for damage to agriculture in the northeastern United States. The specific functions of the program were to measure atmospheric oxidant concentrations at different locations within the region during the growing season and to observe foliar injury to indicator plants in order to determine the frequency of occurrence and distribution of oxidants and the phytotoxicity of the atmosphere.

The Mast Ozone Meter was chosen for measurement of atmospheric oxidant concentrations because it was commercially available, relatively inexpensive and could be operated continuously. Tobacco was selected as the biological indicator because certain varieties: 1) are highly susceptible to oxidants; 2) produce readily discernible foliar markings; 3) continue to produce susceptible tissue up to the flowering stage; and 4) have been successfully used as indicators of atmospheric oxidants in the past.

It was anticipated that compilation of data in a standardized manner from different locations within the region would provide information on the current impact of oxidants on vegetation and the usefulness of these techniques for biological and chemical monitoring of the phytotoxicity of the atmosphere. This information could then be used to assess the impact of oxidants on agriculture in the northeast, to improve current air quality criteria and to evaluate standards and implementation plans designed to protect agriculture from the injurious effects of atmospheric contaminants.

The program, initially designed to cover the northeast region, was extended to include locations in the Middle Atlantic States (see Fig. 1). The number of participants varied from year to year depending on interest and the availability of equipment and manpower. This report provides a summary and evaluation of the methods used and data obtained in the cooperative regional program beginning with 1968, the first year that a concerted effort was made to standardize methods of data collection. The results are presented and discussed in a manner that is intended to be useful to the cooperating Stations in their agricultural research and to the States and Federal government in their efforts to improve air quality.
Source: 2

#895
Jacobson, J.S. and A.C. Hill (eds.). Recognition of Air Pollution Injury To Vegetation: A Pictorial Atlas, Air Pollution Control Association, Pittsburgh, Pa., (1970).

Photos depicting type of damage to different plants by a number of air pollutants. Description of injury.
Source: 8

#136
Jacobson, J.S., L.H. Weinstein, D.C. McCure and A.E. Hitchcock. "The accumulation of fluorine by plants." J. Air Pollution Control Assoc., 16(8):412-417 (1966).

The accumulation and distribution of fluorine (F) in plant leaves have been studied to better understand the response of plants to concentrations of atmospheric fluoride (F) that are similar to those found in urban or industrial areas. The results indicate that F from the air can be adsorbed to the surface of leaves as well as accumulated internally and that F in leaves can be translocated outward to the surface as well as upward to the tips. F injury and accumulation can be induced in any desired location on a gladiolus blade by restricting gas exchange of the blade, indicating that all parts of a blade are sensitive to F-induced injury. It is, therefore, suggested that the wide differences often found between plant species and varieties with respect to both susceptibility to injury and degree of F accumulation may be explained by differences in the means of accumulation, translocation, and distribution of F. F remains in a soluble form in plant leaves and maintains the chemical properties of free, inorganic F. The solubility and mobility of F and the ease of removal from plant tissues indicate that irreversible binding to cellular components does not occur.
Source: 7, 6

#486
Jaeger, H. J. and E. Pahlich. "Einfluss von SO_2auf den Aminosaeurestoffwechsel von Erbsenkeimlingen." (Influence of SO_2 on the amino acid metabolism of pea seedlings.) Text in German. Oecol., 9(2):135-140 (1972).

Long--termed fumigation of pea seedlings with sulfur dioxide caused typical alterations of the concentration of free glutamate and glutamine as well as fluctuations of the activity of glutamate dehydrogenase and glutamine synthetase. Shortly after fumigation with low concentrations of SO_2 began, the amount of glutamate increased, while the concentration of glutamine increased independently of the concentration of SO_2. The activity of glutamate dehydrogenase, reductive amination of alpha-ketoglutarate, generally increased. In roots of fumigated seedlings the effects of SO_2 on the concentration of glutamate and glutamine as well as the activity of glutamate dehydrogenase are similar to those observed in shoots. Metabolic sequence derived from glutamate seem to be activated by SO_2 as can be seen by the increase of the concentration of glutamine and gamma-aminobutyric acid.
Source: 1

#1411
Jaeger, H. J., E. Pahlich, and L. Steubing. "Die Wirkung von Schwefeldioxid auf den Aminosacure und Proteingehalt von Erbsenkeimlingen." (The effect of sulfur dioxide on the content of amino acids and protein in pea seedlings). Translated from German. Angew. Botan, 46:199-211 (1972).

The effects of sulfur dioxide on the protein and soluble amino acid content of pea seedlings were investigated in a controlled climate chamber. Characteristic alterations in the protein and amino acid concentrations were determined and were related to exposure time, SO_2 concentration and plant age. The mechanism of SO_2 damage was examined.
Source: 1

#294
Jaffe, L. S. "Ambient carbon monoxide and its fate in the atmosphere." J. Air Pollution Control Assoc., 18(8):534-540 (August 1968).

Carbon monoxide, the most abundant air pollutant found in the atmosphere generally exceeds that of all other pollutants combined (excluding CO_2). An estimated tonnage of more than 87 x 1,000,000 of CO was emitted in the United States from major technological sources alone during 1966. More than 90% of the total CO emitted from fossil fuels is derived from gasoline powered motor vehicles. Other sources of CO include emissions from coal and fuel oil burning, aircraft and open burning. Some CO is also formed by certain vegetation and marine invertebrates (siphonophores). Chemical reactions of CO in the upper and lower atmosphere are discussed. Chemical oxidation of CO in the lower atmosphere by molecular oxygen is very slow. The exact duration of CO in the lower atmosphere is not known with certainty; however, the mean residence time has been variously estimated to be between 0.3 and 5.0 years. In the absence of scavenging processes the estimated world-wide CO emission would be sufficient to raise the atmospheric level by 0.03 ppm per year, yet the background levels of CO in clean air do not appear to be increasing. Several potential sinks are discussed. Knowledge of the mechanism of process of removal of CO from the lower atmosphere is unsatisfactory; the process, at the present time, cannot be identified with certainty.
Source: 1

#1425
Jaffe, Louis S. "The global balance of carbon monoxide." American Assoc. for the Advancement of Science, Washington, D.C., Global Eff. Environ. Pollut., Symp., Dallas, Texas, 34-49 (1968).

Carbon monoxide, principally a man-made pollutant, is the most abundant pollutant in the lower atmosphere. Total emissions from technological sources alone exceed the combined total of all other pollutants (excluding carbon dioxide), with a total estimated U.S. tonnage in 1968 of 102 million tons. Fuel combustion by motor vehicles is by far the major source; other important sources are industrial processes, aircraft exhaust, solid waste combustion, man-made fires, and stationary fuel combustion. Natural sources include wild forest fires. Urban CO concentrations have diurnal, weekly, and seasonal

patterns, depending on human activity and meteorologic factors. Mean levels of 50 ppm have been measured in heavy traffic, while background levels in remote areas range from about 0.01 to 1 ppm. The annual global emission from all sources is about 250 million tons. CO is relatively chemically inert in the troposphere; chemical oxidation of CO in the lower atmosphere by molecular oxygen is very slow. Estimates of mean residence time of atmospheric CO range from 0.1 year to five years; without scavenging processes, the estimated annual increase in background levels would be about 0.04 ppm, yet background levels in clean air appear stable. A number of potential removal mechanisms are discussed, including upper atmospheric migration, biological metabolism by terrestrial and/or marine organisms, biochemical combination with porphyrin compound, oceanic absorption, and adsorption on various surfaces. However, the precise removal mechanism is unknown at present.
Source: 1

#1424
Jaffe, L. S. "Carbon monoxide in the biosphere; sources, distribution, and concentrations." J. Geophys. Res., 78(24):5293-5305 (August 20 1973).

Sources, distribution, and concentrations of carbon monoxide in the biosphere are reviewed. Total annual tonnages of CO from man-made sources exceeded 132 million metric tons in the United States and 359 million metric tons globally in 1970. The largest single technological source of CO is the internal combustion engine. Atmospheric CO abundance in the biosphere of urban areas is not uniformly distributed and is dominated by the anthropogenic sources, being related to proximity to the source, human activity patterns, and meteorological factors. These concentrations range from about 1 to over 70 ppm, with brief peak levels in dense traffic as high as 140 ppm. The removal of CO from the atmosphere, as well as the sources and dispersion, controls the local concentration. Man's CO production considered on a global basis is relatively minor in comparison with natural source production which includes atmospheric oxidation of methane, the ocean, decay of plant chlorophyll, and terpene oxidation from plant sources. Their total source strength is estimated at 3-25 times the man-made sources as a whole. Background concentrations, from both natural and anthropogenic sources, normally range from 0.04-0.20 ppm, with natural occasional concentrations being as high as 0.80 ppm at ground level in remote clean air areas. The higher concentrations are found in the northern hemisphere. Estimated global CO emissions are tabulated from various industrial, non-industrial, and transportation activities of man.
Source: 1

#487
Jakubczak , Z., and J. Pieta. "Some morphological variations of the needles and shoots of Scots pine/Pinus silvestriis L./ in the polluted surroundings of nitrogen plant at Pulawy." Polish Acad. of Sciences, Zabrze, Research Inst. of Upper Silesian Industrial Region, Mater. Miedzynardowej Konf. Wplyw Zanieczyszcen Powietrza na Lasy, 6th, Katowice, Poland, p. 327-335 (Sept. 9-14 1968).

In the early spring of 1967, the first symptoms of damage to pine trees were observed in the vicinity of a nitrogen plant at Pulawy, Poland. A strong yellowing and premature needle fall were noted. Morphological analysis revealed a strong elongation of the needles of Scots pine in the damaged stands. Shoots with pathologically elongated needles were significantly shorter than shoots with the needles of normal length. This distribution of needles on the damaged shots was more compressed in comparison with the unaffected trees.
Source: 1

#1412

James. H. A. "Survey of arsenic and fluorine levels in vegetation in the Rodeo-Crockett areas." 1963-1964.Preprint, Bay Area Air Pollution Control District, San Francisco, Calif., 11 p., April 1965.

Arsenic and fluoride levels in vegetation of the San Francisco Bay area(Rodeo-Crockett areas of Contra Costa County)were determined over the period September 1963 to August 1964 to determine if various industrial sources, particularly a brickworks facility and a lead smelting operation, were contributing to previously observed plant damage. Twelve monthly vegetation samples were taken at six sites in the area, lime-paper strip samples were taken at the same sites plus one additional location. Fluoride in excess of the safe level for beef cattle (50 ppm soluble fluoride) was found in five of 71 pasture grass samples taken during the survey; elevated arsenic levels coincided with the high fluoride levels in the same samples. Grass sample results were generally in agreement with lime paper data for fluoride and arsenic. Seasonal wind data, visual evidence of plant damage and the analytical findings suggested that the major contributing source, both for fluorides and arsenic, was in the Selby area.
Source: 1

#810

James, P. W. "The Effect of Air Pollutants Other Than Hydrogen Fluoride and Sulphur Dioxide on Lichens." In: Air Pollution and Lichens. B. W. Ferry, M. S. Baddeley, and D. L. Hawksworth (eds.), Toronto, Toronto Univ. Press 1973, Chapt. 8, p. 143-175.

The effects of heavy metals, smokes, and farming chemicals on lichens are reviewed. Heavy metal fallout, especially of copper, cadmium, iron, lead, manganese, nickel, and zinc, result from smoke particulates from the partial combustion of coal and oil and from smelting processes and vehicle exhausts. The maximum tolerance levels for individual metals are not known, but heavy metal pollution can be lethal. Mechanical effects of the deposition of particulate smoke emissions as well as airborne dust from quarry workings and road usages are known. Heavy dust fallout appears to be lethal to most species. There is evidence of air pollution damage caused by farming techniques using artificial fertilizers, fungicidal sprays,and selective weed killers. Other dangerous pollutants are radionuclides and ionizing radiation.
Source: 1

#488

Jamrich, V. "Je stabilita chlorofylu faktorom odolnosti proti dymu?" [Is chlorophyll stability a factor in the power of resistance against fumes?]. Zbornik Vedeckych Prac Lesnickej Fakulty Vysokej Skoly Lexhickej a Drevarskij Vo Zvolene, 1:7-14 (Oct. 1968).

The relationship between the intensity of the effects of gaseous fluorine compounds, in the form of industrial emissions, and the degree of chlorophyll destruction in two species of trees was studied. Alnus glutinosa was selected to represent the resistant species, and Quercus patraea to represent the species of low resistance. Each species was exposed to a definite amount of fluorine, and the degree of depigmentation was expressed in terms of the differences in the total chlorophyll and the differences found in the components, chlorophyll a and chlorophyll b. The degree of chlorophyll destruction is directly proportional to the intensity of exposure to fluorine; the degree of depigmentation is also dependent on the strength of the chlorophyll bonds in the plastid structures. Depigmentation is continuous with changes in the ratio of chlorophyll components, and chlorophyll b is relatively more stable than chlorophyll a.
Source: 1

#336

Janczewski, H. "Wplyw gazu ziemnego na roslinnosc a zwlaszcza drzewa." [Influence of natural gas on vegetation, especially trees]. Gaz Woda Tech. Sanit. (Warsaw), 45(4):118-121 (1971).

Penetration of natural gas into the soil, which in some instances is estimated to be as high as 40 l/hr, lowers the terrestrial oxygen concentration, increases the carbon dioxide concentration, and causes the drying out and death of trees. Of 128,000 trees in various regions of Holland, about 2540 trees died in 1967 as a result of exposure to gas ir the soil. In another analysis of 1736 Netherland trees, 22% perished because of gas exposure, 34% died of unknown causes, and another 24% perished as a result of storms, hurricanes, and infections. The percentage mortality of trees was not significantly correlated with age, although the somewhat higher death rate of trees of advanced years was probably related to their location in older areas of cities where the gas conducting networks generally have more leakage. No relationship was observed between seasonal factors and tree mortality, and none of the species was more susceptible to the toxic effects. However, other factors contributing to tree mortality included an increase in vehicular traffic, underground construction, or construction of high buildings, trains, paving of streets, climatic effects and changes in the soil water content. Because of natural gases greater pressure in the conducting pipes and low moisture content, it is deleterious for conducting pipes than manufactured gas, since it has a tendency to dessicate and distort the connections between pipes which are sealed with lead and hemp rope. Natural gas showed about 20 leakages/km of conducting pipe, compared to six such leakages for manufactured gas. Three methods of removing gas from the soil by either compression, drainage, or ventilatory openings are briefly evaluated.
Source: 1

#489
Janson, A. "Ueber Rauchsaeureschaevms." (On flue gas damage). Angew. Botan., 7:46-52 (1925).

Plants are a more reliable source of information about the presence of air pollutants than chemical or microscopic studies. Sulfur dioxide is the main noxious agent for the plant world. A range of susceptibility to this agent includes plant species such as ordinary spruce and vegetable garden beans. These species are marker species in pollution exposed areas. Breeding and cultivation may affect plant susceptibility to pollutants. Reference is made to certain apple tree species in which highly resistant features against adverse weather conditions were developed, but which, nevertheless, are highly susceptible to pollutants, as opposed to other apple species. Differences in susceptibility may occur within the same species. The diffusion of SO2 is an important factor affecting plant damage. The higher the stack of the emitting source, the more delay is seen in the pollutant effects.
Source: 1

#1414
Japan Public Health Assoc. "Sholuhinchu no kadomyumu ni kansuru kenkyu. Kome no kadomyumu nodo o shihyo to suru kankyo osen no handan shakudo. Koseisho kogai chosa kenkyuhi ni yoru." (Study on cadmium content in food: Criterion for environmental pollution based on CD content in rice, supported by survey and research fund on public pollution from the ministry of health and welfare). Rept. AOKI-21, 110 p. (March 31, 1969).

Results are presented from a study of the cadmium content in Japanese food, with a criterion being developed for environmental pollution based on rice Cd content. Cadmium distribution was studied by type of food, by district, and amounts of the metal in food. Standardization of analytical methods for Cd in food was also studied. A wide range of Cd distributions were found, regardless of type of food and locality, including so-called nonpolluted areas. An average CD content in unpolished rice of 0.4 ppm was established as a suitable criterion for establishing Cd pollution for a given area. Atomic absorption spectrometry was used as the standard method for analyzing Cd in food, with appropriate wet or dry methods of decomposition being selected depending on the kind of food to be examined. The dithizone-chloroform analytical method is also useful.
Source: 1

#1415
Japan Society of Air Pollution, Research Committee. "Taiki osen shokubutsu higai shashin-shu." (Photographs of plants damaged by air pollution). 239 p. (March 1973).

Plant damage by air pollutants are displayed in hundreds of photographs. Pollutants such as sulfur dioxide, nitrogen dioxide, and ozone necrosis between veins of leaves, hydrogen fluoride causes necrosis at the edges of leaves. Oxidants such as aldehydes and peroxyacetyl nitrate (PAN) cause the formation of silver-grey color on the backs of leaves.

At lower pollutant concentrations, chlorosis of leaves or invisible injuries such as plant growth retardation occurs. Plants weak in resistance to SO2 are alfalfa, barley, cotton, marvel-of-Peru, rhubarb, cosmos, and sweet pea; those strong in resistance are musk melon, citrus fruits, celery, and chrysanthemum. The resistance to SO2 increases as the humidity decreases. The threshold value of HF was several ppb using gladiolus as the indicator plant. The resistances of plants to air pollutants depend not only on the plant and pollutant, but also on meteorological conditions and planting conditions.
Source: 1

#1416

Jenkins, D. W. "Global biological monitoring." In: Man's Impact on Terrestrial and Oceanic Ecosystems. William Henry Matthews (comp.). Cambridge, MIT Press, Chapt. 22, p. 351-370,(1971).

Three methods of study are required to survey and monitor the conditions of the plants and animals of the world. These are international networks using: biological censuses and surveys; and ecological base-line monitoring stations. Biological monitors can be plant, animal, and/or human, and consist of the following types: sentinels, which are highly sensitive organisms serving as early warning devices of dangerous situations; bioassay monitors, which are used as bioreagents to detect or monitor the presence and/or concentration of pollutants; detectors, which are individual species showing a measurable response to pollutants or environmental changes; indicators, which are specific organisms whose presence indicates the probability of pollution or dangerous organisms associated with pollution; and accumulators, which absorb and accumulate a pollutant in measurable quantities. Biological surveys are broad geographic surveys of the population size, reproductive success, and health of species of living organisms, particularly those high in the trophic or food chain levels. Surveys of plants should also be carried out on a broad scale. Ecological base-line monitoring stations should be established to show general changes of major significance to the flora and fauna of the world. These stations should be located in representative biome regions on land and in estuaries and the ocean. In addition to biological monitoring, they should be designed to monitor general changes in climate and the presence of various man-induced contaminants and pollutants. The major environmental parameters of global importance which should be monitored are hydrocarbons, of which the most important are DDT and the aldrin-group pesticides and toxic metals.
Source: 1

#1172

Jensen, J. "Some investigations on plant uptake of sulfur." Soil Science, 95:63-68 (1963).

Soil analyses showed that the sulfate content in the surface soil was low, but that it varied with the season. Higher contents were often found in the lower-lying layers by profile examinations.

An increase of the total sulfur content of the soil was only achieved by the use of organic fertilizers; superphosphate with 12 to 13 per cent S had no effect in this respect.

The soil analyses indicate that the supplying of the plants with sulfur through precipitation and directly from the air may be of great importance.

The quantity of sulfur added in the precipitation is comparatively uniformly distributed in Denmark, with an average of about 13 kg. per ha. annually.

Pot experiments with different species of plants supplied with S35 confirmed the quantitative significance of the sulfur content of the precipitation and the air for the nutrition of the plants.
Source: 6

#523

Jensen, K. F. "Absorption, translocation, and soil deposition of aerial pollutants by vegetation." Proc. Soil Conserv. Soc. Am 28:26-29 (1973).

The report states that three of the largest natural sinks are oceans, soil, and vegetation. The rate of uptake of a large group of aerial pollutants by herbaceous plants, such as alfalfa, oats, beans, are given. Also, there is data of air pollutants absorbed by forest, and of dust particles becoming entrapped by forests. The mechanism of absorption is discussed. Factors affecting absorption are cited. Translocation, utilization, and soil deposition of pollutants is discussed by the use of citations of former studies.
Source: 2

#490

Jensen, K. F. "Response of nine forest tree species to chronic ozone fumigation." Plant Disease Reptr., 57(11):914-917 (November 1973).

Yellow poplar, green ash, white ash, sycamore, red maple, silver maple, sugar maple, black walnut, and European black alder seedlings were fumigated with 30 pphm ozone for 5 mo. Significant reductions in growth of sycamore, sugar maple, and silver maple were found. The fumigated seedlings also tended to lose their leaves sooner than the unfumigated seedlings. The relationship between these findings and sensitivity classifications based on symptom development are discussed.
Source: 1

#128

Jensen, K. F. "Sulfur content of hybrid poplar cuttings fumigated with SO_2." USDA Forest Service Research. Upper Darby. Research Note NE-209. (1975).

Hybrid poplar cutting were fumigated with sulfur dioxide ranging in concentration from 0.1 to 5 ppm for periods of 5 to 80 hours. At the end of the fumigation periods, the cuttings were harvested and the sulfur and chlorophyll contents of the leaves were measured. At 0.1 ppm and 0.25 ppm the sulfur content initially increased, but decreased as fumigation continued. At 3 ppm and 5 ppm the sulfur content of the leaves significantly increased, and foliar injury was apparent. No statistically significant change in chlorophyll content was observed.
Source: 6, 7

#1174

Jensen, K.F., F.W. Bender, and R. G. Masters. "A two-cell chamber for measuring gas exchange in tree seedlings." USDA Forest Service Research. Research Note NE-178. (1973).

A two-celled chamber for measuring gas exchange in tree seedlings is described. Temperature is controlled within + 0.5°C by means of a copper coil. The two cells are independent of one another, and one cell can be used a preconditioning cell while gas exchange measurements are being made in the second cell.
Source: 6

#1175

Jensen, K.F., and L.S. Dochinger. "Responses of hybrid poplar cuttings to chronic and acute levels of ozone." Environmental Pollut., (6):289-294 (1974).

Hybrid poplar cuttings were exposed to either 0.15 ppm ozone for 6 weeks or 1 ppm ozone for 2, 4, or 8 h. The chronic ozone treatment reduced growth by 50% and caused injury to 75% of the leaves. The acute ozone treatment had no effect on growth but caused injury to 70% of the leaves 48 h after fumigation.
Source: 6

#138

Jensen, K. F., and T. T. Kozlowski. "SO_2 absorption and translocation in forest tree seedlings." Am. J. Bot., 61(5):28 (1974)

One-year-old seedlings of Acer saccharum Marsh., Populus grandidentata Michx., Fraxinus americana L. and Betula alleghaniensis Britton (Betula lutea Michx. f.) were fumigated with sulfur dioxide (SO_2). SO_2 absorption rates were measured for seedlings that had not been fumigated and for those that had been prefumigated with 0.75 ppm SO_2 for 6, 20, or 34 hours. The fumigations were 8 hours per day. With no prefumigation, Populus grandidentata had the highest SO_2 absorption rate and Acer saccharum the lowest rate. With 20 hours or more of fumigation, the absorption rate of all species except Fraxinus americana was reduced. Translocation of absorbed sulfur was measured with $^{35}SO_2$. The amount of radioactive sulfur in leaves, upper stem, lower stem, and roots was determined on the day of fumigation and 2, 4, and 8 days after fumigation. For the first four days, most of the radioactive sulfur was found in leaves but by the eighth day large amounts were also found in the roots. The amounts of sulfur translocated to roots varied with species.
Source: 7

#1176

Jensen, K. F., and T. T. Kozlowski. "Absorption and translocation of sulfur dioxide by seedlings of four forest tree species." J. Environ. Qual., 4(3):379-382 (1975).

Rates of absorption of SO_2 and of translocation of absorbed sulfur were determined in sugar maple (Acer saccharum Marsh.), bigtooth aspen (Populus grandidentata Michx.), white ash (Fraxinus americana L.) and yellow birch seedlings (Betula alleghaniensis Britton(Betula lutea Michx. f.). Bigtooth aspen, a sensitive species, had the highest absorption rate with no prefumigation and sugar maple, a tolerant species, had the lowest. After 20 hours or more of prefumigation with 1,965 $\mu g/m^3$ (0.75 ppm)SO_2, the rate of sulfur absorption was reduced in all species except white ash, a species intermediate in sensitivity. The relationship between species sensitivity and absorption rate thus changed with the prefumigation treatment. The foliar sulfur content of all species increased with SO_2 fumigation. Sulfur-35 absorbed from the atmosphere as $^{35}SO_2$ was concentrated mainly in the leaves shortly after fumigation, but by the eighth day had been translocated throughout the plants. Amounts of sulfur translocated to roots varied with species.
Source: 6

#1173

Jensen, K. F., and R. C. Masters. "Growth of six woody species fumigated with ozone." Plant Disease Reporter, 59(9):760-762 (September 1975).

White birch, yellow birch, bigtooth aspen, eastern cottonwood, Japanese larch, and white spruce seedlings were fumigated with 25 pphm ozone for 10 days. Height growth of the white birch seedlings was reduced, but not by a significant amount; growth of the other species was not affected. The number and size of the white birch leaves were also reduced during the fumigation period.
Source: 6

1417

Jiracek, V., I. Machackova, and J. Kostir. "Nachweis der Bisulfit-Addukte (alpha-Oxysulfonsaeuren) von Carbonylverbindungen in den mit SO_2 behandeiren Erbsenkeimimgen." (Detection of bisulfite adducts (alpha-oxysulfonic acids) of carbonyl compounds in SO_2-treated young pea plants). Text in German. Experientia, 28(9):1007-1009 (Sept. 15, 1972).

The intoxication of 15-day-old green pea seedlings with 1% gaseous SO_2 caused an important fall of some free ketoacids (pyruvic, oxaleacetic, alpha-ketoglutarie) and of glyceraldehyde in the roots and shoots. This fall was a consequence of the reaction for these carbonyl compounds with SO_2 in the plant tissue under the formation of bisulfite adducts (alpha hydroxysulfonic acids), which were chemically proved and quantitatively estimated.
Source: 1

#1418

John, M. K. "Lead availability related to soil properties and extractable lead." J. Environ. Quality, 1(3):295-298 (July-September 1972).

Lead contamination of the soil has been attributed to combustion of leaded gasolines, metal smelting, and insecticide sprays. Lead availability to plants and its relationship to soil lead and other soil properties were studied. The lead content of lettuce and oats was related to lead extracted from 29 contaminated soils by several different extraction procedures. Correlation studies showed that 1N nitric acid extractable lead was significantly related to lead in lettuce, however, milder extraction with 0.01N nitric acid and 1N ammonium acetate provided a better correlation with lead content of oat shoots and roots. Soil properties, particularly soil pH, were also important when attempting to predict plant lead. Lead availability was related to soil pH, extractable alumuminum, and total nickel. No relationship with organic matter was observed.
Source: 1

#1177

John, M. K. "Cadmium uptake by eight food crops as influenced by various soil levels of cadmium." Environmental Pollution, (4):7-15 (1973).

Since cadmium accumulation in man has been implicated as the cause of several health problems, reduced dietary intake of this non-essential metal is desirable. A method for minimisation of cadmium content of food crops is needed since potentially hazardous levels in plants may result from cadmium uptake from contaminated soils. Study towards that objective involved the comparison of cadmium in various parts of eight food crops when grown under three soil cadmium regimes. Cadmium concentrations in some plants were influenced more dramatically by soil cadmium treatments than other plant sections. For particular crops and regimes of soil cadmium, accumulation of cadmium in root portions was noted. Among the edible plant parts, highest cadmium levels were found in lettuce and spinach leaves, and were followed by levels in brassica tops, radish and carrot tubers, pea seeds, and oat grains. Cadmium phytotoxicity significantly diminished yields of some parts.
Source: 6

#491

John, M.K., H.H. Chuah and C.J. VanLaerhoven. "Cadmium contamination of soil and its uptake by oats." Environ. Sci. Technol., 6(6):555-557 (June, 1972).

The extent of cadmium contamination of soils in the Lower Fraser Valley (S.W. BC, Canada) was evaluated. Nitric acid-soluble cadmium in the surface samples among 33 agricultural soils averaged 0.88 ppm. However, nitric acid-soluble cadmium reached as high as 95 ppm in a surface sample taken near a battery smelter, but this level decreased considerably with distance and depth. The effect of soil application of carbonate, nitrate, chloride, sulfate, and phosphate salts of calcium on cadmium uptake by oats was determined in a growth chamber study involving soils taken near a battery smelter and from farmland. Oats grown on the contaminated soils contained very high amounts of cadmium in the roots, with smaller amounts in the above-ground portions. Soil treatments affected the cadmium content of roots significantly but did not affect the cadmium content of tops.
Source: 1,6

#204
John, M. K., and C. Van Laerhoven. "Lead uptake by lettuce and oats as affected by lime, nitrogen, and sources of lead." J. Environ. Quality, 1(2):169-171 (1972).

The effects of lime, nitrogen, and lead applications, whether alone or in various combinations, on plant yield, lead content, pH of the soil, and elemental plant composition were investigated. Soil application of lead increased lead uptake by lettuce to a greater degree than by oats. Application of lime repressed the uptake of added lead by both plants, while application of low levels of nitrogen reduced lead uptake by lettuce and oat roots only. Application of lead chloride decreased the amount of sulfur and phosphorus in plants, but levels of other elements were not affected by lead treatment.
Source: 1

#203
John, M. K., C. J. VanLaerhoven, and H. H. Chuah. "Factors affecting plant uptake and phytotoxicity of cadmium added to soils." Environ. Sci. Technol., 6(12):1005-1009 (November 1972).

Smelting and electroplating of metals, motor oils, motor vehicle tires, and fungicide sprays are sources of cadmium in the environment. The factors affecting plant uptake and phytotoxicity of cadmium added to soils were investigated. For a set of 30 surface soils, the addition of 50 mg Cd (from $CdCl_2$) to 500 g of soil reduced yield and sharply increased Cd levels in analyzed portions of radish and lettuce plants when compared to those plants grown on control soil. For the treated soil, plant Cd was significantly related to Cd in the soil. From among 18 potential independent variables, stepwise linear regressions to predict Cd found in plant parts harvested for treated soils included a measure of the relative ability of soils to absorb Cd, acetate-soluble Cd in the soil, soil reaction, and organic matter as significantly contributing independent variables. Plant Cd levels were significantly correlated with amounts of nickel, iron, zinc, and copper in the same plant portion.
Source: 1

#1087
John, M.K., et. al. "Mercury in soils of British Columbia." Water, Air & Soil Pollution, 5(2):213 (1975).

Mercury concentrations in various horizons of British Columbia soils were determined to estimate natural background levels in soils from various geographical areas of the province. Highly enriched concentrations near the Pinchi Lake cinnibar deposit declined to background levels ranging from 10 to 310 ppb Hg in the district. In six other regions, concentrations in surface mineral horizons averaged 85 ppb and ranged to 490 ppb but surface horizons of peaty muck soils and those predominated by vegetative litter contained 164 ppb Hg on the average and as much as 741 ppb. Concentrations in subsurface horizons were lower than at the surface. A significant relationship between Hg concentration and organic matter content was observed. Comparison with soils from outside British Columbia indicated its location within a generalized mercuriferous belt accounted for the relatively high concentrations observed.
Source: 1

#534

Johnsen, I., and D. Sochting. "Influence of air pollution on the epiphytic lichen vegetation and bark properties of deciduous trees in the Copenhagen area." Oikos, Acta Oecol Scand., 24(3):344-351 (1973).

The epiphytic lichen vegetation of trees in the Copenhagen area was mapped and the pH, total sulphur content and buffer capacity of its substratum were measured.

The SO_2 air pollution during two consecutive winters was mapped. The SO_2 isopleths coincide well with the inner distribution limits of the lichens, indicating specific critical SO_2 levels for the different species. The critical level for Buellia punctata (Hoffm.) Massal. was 90-110 $\mu g\ m^{-3}$ for Xanthoria parietina (L.) Th. Fr. 80-90 $\mu g\ m^{-3}$, for Lecanora subfusca coll. 70-80 $\mu g\ m^{-3}$ and for Physcia pulverulenta (Schreb.) Hampe 40 $\mu g\ m^{-3}$. These species were considered useful as indicators for biological evaluation of SO_2 pollution in the investigation area. The bark properties changed as follows on approaching the city centre to the average pH decreased from 5.0 to 3.0 whilst the average sulphur content in per cent dry weight increased from 0.25% to 0.45%. The buffer capacity of bark was higher both in the city centre and the rural districts than in the intervening area at the periphery of the city.
Source: 2

#1274

Johnson, N. M., R. C. Reynolds, and G. E. Likens. "Atmospheric sulfur: its effect on the chemical weathering of New England." Science, 177(4048): 514-516 (August 11, 1972).

The acidity and sulfur content of the upland streams of New England can be accounted for by the rainout and washout of sulfuric acid from the atmosphere originating from sulfur dioxide produced during the combustion of fossil fuels. Rain and snow at Hubbard Brook, New Hampshire, contained an average of 3.1 mg/l sulfate and had an associated pH of 4.1. Over a 3-year period, rain and snow in the Northeast contained an average of 4.3 mg/l sulfate with an associated pH of 4.4. Normal precipitation has a pH of only 5.7. Data are given on the composition of surface waters of the Hubbard Brook, Maritime Provinces, and New England areas. Weathering is an important source of minerals in surface water. Carbonation weathering reactions or congruent solution of minerals, or both, are realized on a regional scale and are the primary processes responsible for most of the observed cationic denudation. Although higher weathering rates are expected at higher pH levels of rainwater. Hubbard Brook had a relatively slow weathering rate. A contributing cause may be the maturity of the soil at Hubbard Brook. In spite of the excess acid over New England, the rate of cationic denudation of upland watersheds is relatively low.
Source: 1

#1004

Johnstone, H. F., and D. R. Coughanowr. "Absorption of SO_2 from air oxidation in drops containing dissolved catalysts." Ind. Eng. Chem., 50(8): 1169-1172 (1958).

The rate of SO_2 oxidation in drops of catalyst solutions suspended in air was studied and compared with the rate of SO_2 absorption and oxidation by drops containing H_2O_2. A single drop of 300 microns catalyst solution was exposed to humid air containing SO_2 and analyzed for its acid content. For comparison, the rate of absorption of SO_2 from air by stationary drops of dillute H_2O_2 was measured. The rate of reaction of the catalysts solution was always constant until the O_2 content of the solution was essentially depleted. The rate of formation of H_2SO_4 in a drop of catalyst solution depends on the partial pressure of SO_2 and the nature and concentration of the catalyst. For high concentrations of catalyst, the reaction takes place in the outer shell of the drop; SO_2 doesn't penetrate to the center.

The catalytic reaction takes place in dark as well as light. However, the concentration of H_2SO_4 in an acid droplet increases with the inverse cube of the DIA as the droplet evaporates in an air flow of low relative humidity. Source: 5

#978

Johnstone, H.F. and P.W. Leppla. "The solubility of SO_2 at low partial pressures." J. Am. Chem. Soc., 56:2233-2238 (1934).

The solubility of sulfur dioxide in water has been measured between 0.2 and 10.3 mm. at 25, 35 and 50°. The ionization constants of sulfurous acid have been calculated from the conductance data of Morgan and Maass and Campbell and Maass at 0, 10, 18, 25, 35 and 50°, using ion mobilities and activities corrected for the ionic strength of the solutions. The ratio of the molality of the un-ionized molecules to the pressure is the same for the high concentrations measured by Maass and his co-workers as that found for the very dilute solutions by means of the equation, $(m + \gamma \pm)^2 + Km + - Km = 0$. The free energy and heats of ionization and of solution have been calculated from the equilibrium constants. The total heat of absorption of sulfur dioxide in infinite dilution is -10,120 cal. This value agrees with that obtained by extrapolating the data of Stiles and Felsing to infinite dilution. Source: 5

#1419

Jonas, H. "Action of air pollutants on the biosynthesis of secondary plant products." Econ. Bot., 69(3):210-214 (1969).

The effects of ozone, its reaction products with nitrogen dioxide and olefins, and sulfur dioxide on the biosynthesis of secondary plant products which are pharmaceutically valuable are reviewed. Ozone damage to plants such as tobacco can be higher in exposure to light. Several protective measures for plants are available, such as using ascorbate and spraying sugar on leaves. The effects of pollutants which form during photochemical smog initiated by automobile exhausts on plants are described. Nitrogen

dioxide injures plants in proportion to the opening of the stomata; peroxyacetyl nitrate (PAN) attacks the spongy leaf parenchyma and inhibits the Avena coleoptile test for indole-3-acetic acid. Photosynthesis is depressed by PAN. Respiratory reactions can be inhibited by PAN and smog. The inhibition of the principal electron transfer systems within and outside of the dicarboxylic acid cycle will retard the rate of biosynthesis of secondary products.
Source: 1

#971
Jones, L. H. P. "Form and availability of mineral nutrients in the soil." In: Grassland Research Inst. Annual Report 1971. Grassland Research Inst., Maidenhead (England), p. 17-21 (1971).

Several studies of the form and availability of mineral nutrients in the soil and of the uptake and utilization of mineral nutrients by plants are reviewed. Investigations reviewed concern how much potassium should be applied as a fertilizer to soils to ensure an adequate supply for forage plants, the availability of nonexchangeable potassium to grass, the availability of sulfur to herbage species such as ryegrass, the chemical form and availability of iodine in soils, the availability of trace elements to herbage species such as ryegrass, the uptake of iodine by different herbage species, and the uptake and utilization of nitrogen and sulfur by grass.
Source: 1

#975
Jones, L.H.P., and D.W. Cowling. "Effects of air pollution on plants." (Presented at the National Society for Clean Air, Annual Conference, 39th, Scarborough, England, Oct. 16-20, 1972.) Preprint, National Society for Clean Air, Brighton (England), Part 1, p. 1-13, Part 2, p. 71-79 (1972).

The effects of air pollution on plants are reviewed. Certain features of plants which affect their susceptibility to pollutants are discussed including stomata, leaves and photosynthesis. Pollutants, environmental factors, and specific pollutants (sulfur dioxide, fluorides, smoke, soot, dust, photochemical smog, and oxidant), and plants as indicators of air pollution are reviewed. The paper is then discussed.
Source: 1

#1422
Jones, L. H. P., D. W. Cowling, and D. R. Lockyer. "Plant-available and extractable sulfur in some soils of England and Wales." Soil Sci., 114(2): 104-114 (1972).

Investigations were made by soil and pot-culture procedures of the sulfur status of 16 soils in England and Wales. One group of soils was from the wetter, western region with an annual rainfall above 900 mm and the other group was from the drier, central and eastern region. An organic soil from the dry region had unusually high levels of organic sulfur (.7%) and extractable sulfate and was the only soil to meet fully the sulfur requirements of

of experimental plants. The soils from the wet region had higher contents of organic carbon and sulfur, higher contents of free iron oxides, lower pH values, and higher contents of absorbed sulfate than soils from the dry region. The available sulfur was assessed by measuring the total uptake by perennial ryegrass in pots in a growth chamber with the air filtered to exclude gaseous sulfur compounds. Available sulfur was generally greater in soils of the wet region and was highly correlated with the amounts of soluble plus adsorbed sulfate originally present in the soils and extractable with potassium phosphate solution. The decreases in this fraction during the growth period accounted for 80-94% of the available sulfur, and release through mineralization contributed the remainder, higher levels of available sulfur in the wet region were due to their greater retention of sulfate by adsorption rather than to any difference in previous sulfur inputs through rainfall and fertilizers. The pot-culture experiment included a treatment with added sulfate; the yield of dry matter at each of the harvests was used as a basis for calculating the reduction in yield due to sulfur deficiency. Significant reductions of more than 10% were generally associated with sulfur contents in the plant tops of 0.17% or less. The ratios of total nitrogen to total sulfur in the tops ranged from 8 to 80 and were generally less than 15 until yields were reduced by sulfur deficiency.
Source: 1

#1421

Jones, H. C., J.R. Cunningham, S.B. McLaughlin, N.T. Lee, and S. S. Ray. "Investigation of alleged air pollution effects on yield of soybeans in the vicinity of the Shawnee Steam Plant." Tennessee Valley Authority, Chattanooga, Tenn., Div. of Environmental Planning, Rept. E-EB-73-3, 210 p. (August 1973).

The possible effects of sulfur dioxide injury on soybean yields was investigated for fields in the vicinity of the Tennessee Valley Authority's Shawnee Steam Plant. Two types of air pollution effects were detected on the foliage of soybean plants; intercostal necrosis and chlorosis, both symptoms of injury sometimes caused by SO_2. Soon after the injury occurred necrosis, chlorosis, disease, and insect injury were estimated for 62 jured fields, totaling 1300 acres. Yields and soils were sampled for 110 fields which included 68 affected fields, 38 fields, and four unclassified fields. The average yield for both affected and unaffected fields was 30 bushels per acre. Soil analyses showed that, for most of the fields sampled in the investigation, soil fertility and pH were usually low and in many cases extremely low. Foliar SO_2 injury had no detectable effect on soybean production, and stepwise regression analyses of the data showed that 71-100% of the variation in yields among fields of a given variety could be explained by differences in soil fertility and pH, cultural practices, and soybean cyst nematode infestation.
Source: 1

#1420

Jones, H. C., D. Weber, and D. Balsillie. "Acceptable limits for air pollution dosages and vegetation effects: sulfur dioxide." Preprint, Air Pollution Control Assoc., Denver, Colo. (Presented at the Air Pollution Control Association Annual Meeting, 67th, Denver, Colo., June 9-13, 1974, Paper 74-225.) 31 p. (1974).

An extensive literature review is made to define acceptable limits for sulfur dioxide air pollution dosages in relation to vegetation effects, with acceptable limits being defined as the SO_2 time-average-concentrations that, when exceeded, cause a permanent, adverse effect on vegetation that can be measured in terms of known economic, ecologic, or aesthetic loss. While acceptable limits cannot be fully defined until more experimental data is otained, the following dosages are considered adequate for preventing significant damage to vegetation: maximum 1-hour average of 0.1 ppm for any exposure; maximum 2-hour average of 0.6 ppm for any exposure (maximum peak of 0.1 ppm or less); and maximum 4-hour average of 0.4 ppm for any exposure (maximum peak of 1.0 ppm or less). Additional research is needed to determine the magnitude of acidity levels above background as a result of acid precipitation.
Source: 1

#984

Jordan, C. F. "Terrestrial ecology: introduction." In: Radiological and Environmental Research Division Annual Report. Ecology, January through December 1973. Argonne National Lab, Ill., p. 160-164 (1973).

The studies of the Terrestrial Ecology Program at the Argonne National Lab are discussed. Studies were completed on tritium in ecosystems; the effects of radiation on phtosynthesis, respiration, and carbohydrate metabolism: the economic impact of non-nuclear energy sources on agricultural crops; and the impact of sulfur dioxide on photoxynthesis, respiration, production of soybean plants, and quality of protein and carbohydrates in the soybean fruit. The techniques and equipment used in the study of the effects of SO_2 on soybeans can be used in other experiments regarding the effects of other pollutants on crops. Sulfur dioxide was studied because of its current projected importance as a pollutant.
Source: 1

#987

Jordan, C.F., and M.J. Koziol. "Energy allocation in beans (Phaselous vulgaris L.) following sulfur dioxide exposure." In: Radiological and Environmental Research, Division Annual Report. Ecology. January through December 1973. Argonne National Lab., Ill., p. 165-176 (1973).

Studies of energy allocation by plants have recently been used to investigate functions of various types of plants and plant parts, and how these functions vary in relation to environmental parameters. Little work has been done on the effect of air pollution stress upon energy allocation and use by plants. Changes in energy use by plants subjected to sulfur dioxide were evaluated to gain fundamental knowledge about the functional response

of plants under stress, the terms energy and energy dynamics of plants are used to convey the idea of how solar radiation is captured, stored, and used by the plant to carry out its functions. An effort was made to quantify response as a function of the sulfur dioxide uptake rather than exposure. Seeds of kidney bean plants were grown in exposure chambers and exposed to SO_2. Sulfur dioxide at low levels caused a large and statistically significant increase in the concentration of free sugars in all plant tissues. As SO_2 increased, free sugar increased and then decreased until at relatively high levels where the plants showed large areas of visible damage, the level dropped down to that of the control or slightly below. Sulfur dioxide at low levels also increased starch in leaves. At higher levels, starch concentrations dropped to the level of the controls. During a study of plant metabolism, net photosynthesis decreased and respiration increased as a function of increasing amounts of SO_2. A large part of the photosynthesis reduction was due to the high respiration apparent immediately after the beginning of the dark period. In the study of the effect of SO2 on productivity, by the end of 1 wk of exposure to 1 ppm, there was a significant difference between the dry weight of the plant leaves, stems,roots, and total dry weight of the experimental and control plants. Thus, in response to SO_2 stress, bean plants diverted energy away from synthesis of new tissue and away from storage and kept energy available in the form of sugars to repair and replace damaged cells. This diversion resulted in an increase in respiration, a decrease in net photosynthesis, and a decrease in production.
Source: 1

#993
Juhren, M., W. Noble, and F. W. West. "The standarization of Poa Annua as an indicator of smog concentrations. I. Effects of temperature, photoperiod, and light intensity during growth of the test-plants . Plant Physiol., 32 (6):576-586 (1957).

Poa annua (annual bluegrass) was grown in a greenhouse in various combintions of day and night temperature, photoperiod, and light intensity. At the age of four weeks, the plants were taken out and exposed to smog in standard test boxes. Temperature had a decided effect on plant susceptibility to smog. Plants grown in hot conditions (day 30 C, night 24 C) had a slower growth rate but suffered much less smog damage than plants grown in cool conditions (day 26 C, night 20 C). There was an interaction of light intensitywith temperature; plants in high temperatures grew better with high light intensities and plants in cool temperatures grew better with low light intensities. Eight, 12 and 16-hr photoperiods produce progressively better growth. Even plants grown in the hot conditions were sensitive to smog when shaded for an eight hr photoperiod. Plants grown in hot conditions gained sensitivity when transferred to cool conditions, while those grown in cool conditions lost sensitivity when changed to hot ones. Smog sensitivity was not correlated with the size of plants or growth rate. It was correlated to a high degree with the area over which the stomates were wholly or partly open. It was also correlated with oxidant levels, in data obtained when duration of maximal oxidant readings and climatic conditions were comparable.
Source: 1

#1077
Jung, E. "Bestandesumwandlungen um Rauchschadensgebiete von Ranshofen." (Changes in afforestation of the polluted region of Raushofen). Text in German. Polska Akademia Nau, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zaniecszyszczen Powietrza na Lasy 6th, Katowice, Poland, P. 407-413, Sept. 9-14 (1968).

An aluminum plant in Raushofen is the source of fluorine and tar containing emissions polluting 800 ha of an almost entirely wooded countryside of spruce and white pine with some fir and beech trees. Of this area 120 ha were either completely destroyed by pollution or so heavily damaged that reforestation with more resistant species became necessary. Sixty ha were planted with birches and alders 5 to 6 m high; while they are not a crop yielding culture they form, because of their high resistance to heavy concentrations of pollutants, and excellent protective belt around the aluminum plant. Only in the close vicinity of the ovens did the alder not take hold. There, sallow (Salix caprea) was planted which, while only 1.5 to 2 m high, does contain the heaviest pollution emitted from the ovens. The alder belt is about 600 m deep. The remaining 60 ha furthest from the plant were replanted with larch trees. Two ha were planted experimentally with fir. Parcels of the remaining woods were classified according to a five-point scale with the fifth point denoting the highest degree of pollution damage. Reforestation is ordered when a parcel incurs 40% damage (2.5 on the point scale).
Source: 1

#1427
Junge, C. E. "Sulfur in the atmosphere." J. Geophys. Res., 65(1):227-237 (January 1960).

In unpolluted areas, sulfur occurs primarily in three compounds, sulfate in aerosols and sulfur dioxide and hydrogen sulfide as gas. Sources of SO_4 are the ocean, the soil, and the oxidation of the gaseous compounds. A considerable fraction of the SO_2 is of anthropogenic origin. As measurements in polluted and unpolluted areas indicate, most of the H_2S seems to be natural. In unpolluted air in the northeastern part of the United States, both gases have approximately equal concentrations. The chemistry of the conversion of these gases to SO_4 is discussed. Estimates of the sulfur budget of the global atmosphere, excluding the SO_4 in sea salt particles, indicate that 30% is of anthropogenic origin. Measurements of the chemical composition of Greenland ice back to the year 1915 are presented. The concentration of SO_4 is much higher than that of other soluble constituents, but it has not increased since 1915 as much as one would expect if it were of industrial origin. It is concluded that industrial sulfur is removed from the atmosphere before it spreads to polar regions. This is consistent with estimates of the residence time of about 5 days for SO_2 and about 40 days for total sulfur. More SO_2 enters the oceans with river water than can be accounted for by the weathering of rocks and sediments on land and that the excess must come from the atmosphere. Assuming a closed sulfur cycle, this sulfur must return to the atmosphere as H_2S produced in the shelf areas of the oceans. In view of the considerable amounts of industrial sulfur, it is possible that the global sulfur cycle is not closed and that most of the excess sulfur in river waters is of anthropogenic origin and will stay in the ocean.
Source: 1

#276

Junge, C. E. "The nature and residence times of tropospheric aerosols."In: Man's Impact on the Climate. William H. Matthews, William W. Kellogg, and G. D. Robinson (eds.)., Cambridge, Mass., MIT Press, Chapt. 23, p. 302-309 (1971).

The troposphere contains two reservoirs of relatively short lived atmospheric aerosols; the lower half of the troposphere over continents; and the upper half of the troposphere above continents and most of the total troposphere over the oceans. The main natural sources of tropospheric aerosols are sea spray particles over oceans; dust storms from deserts and dry areas; photochemical and homogeneous gas reactions between hydrocarbons released from plants, and ozone, oxides of nitrogen, ammonia, and sulfur compounds released from the earth's surface; and volcanic eruptions. The aerosol particles vary in size from 0.01 micron in diameter to 100 micron in radius and they show a high degree of internal mixing. The following aerosol parameters can be monitored from ground stations using presently available techniques; total number concentration, optical effects, cloud nuclei concentration, ice nuclei concentration, and total mass concentration. The trends which have already been observed regarding these parameters are discussed, as is the residence time of aerosols.
Source: 1

#1273

Junge, C. "The cycle of a atmospheric gases -- natural and man made." Quart. J. Roy. Meteorol. Soc. (London). 98(418):711-729 (October 1972).

The cycles of natural and man made atmospheric gases and global problems of the troposphere and lower stratosphere are discussed. Atmospheric gases, their average mixing ratios, residence time, and status are listed according to cycles. Cycles include physical and chemical processes, biological and microbiological activities, volcanic exhalations, radioactive decay, and industrial activity. The carbon monoxide cycle includes carbon monoxide, methane, hydrogen, nitrous oxide, carbon dioxide, and ozone. Gases contributing to atmospheric aerosol formation in the sulfur cycle, including sulfate, ammonium, nitrate, chloride, and sodium, are reviewed. The oxidation of sulfurdioxide, photochemical reactions, precipitation, and absorption of SO_2 by the Earth are mentioned. Criteria for a genetic order of atmospheric gases are presented. The role of the biosphere in atmospheric composition is discussed.
Source: 1, 5

#1286

Junge, C. "Basic considerations about trace constituents in the atmosphere as related to the fate of global pollutants." Preprint, American Chemical Society, Washington, D. C. (Presented at the American Chemical Society Meeting, Chicago, Ill., April 1975.) 22 p. (1975).

The processes determining the concentration of atmospheric constitutents, the importance of atmospheric residence time to global transport and dispersion, and estimated residence times of chemically stable organic pollutants are discussed. Atmospheric constituents are divided into three

main categories according to the types of processes determining their global concentrations. Accumulative gases accumulate in the atmosphere because they cannot form important compounds in the sedimentary shell. This category includes no pollutants. The second category of atmospheric gases is controlled by a chemical or physicochemical equilibrium of the earth's surface. Only water vapor and carbon dioxide belong to this category. The most important category includes the constituents whose concentrations are determined by dynamical steady state between sources and sinks. It comprises aerosols and all known trace gases except ozone, which is the only gas that cannot be placed into one of three categories. Removal of stable organic pollutants from the atmosphere can occur by destruction within the stratosphere, dissolution of the gas phase, and removal from the atmosphere by precipitation, attachment to atmospheric aerosols and subsequent removal be washout or rainout, and adsorption at the earth's surface. Stratospheric destruction is not important. Removal of gas phase by rain is a rather inefficient process. Absorption on aerosols may result in global residence times of more than 100 days for polychlorinated biphenyls, mercury, and the chlorofluoromethanes. Excluding degradation in soils and sea water, permament absorption to particles in soils and oceans, with subsequent sedimentation, seems to be the only nonchemical removal process with a long term efficiency.
Source: 1

#1426

Junge, C., B. Bockholt, K. Schuetz, and R. Back. "Nitrous oxide measurements in air and seawater over the Atlantic." Meteor Forschungsergeb., Reihe B, 6:1-11 (June 1971).

Measurements were made of nitrogen dioxide in ocean water and in the air over the North Atlantic from 10 deg S to 60 deg N along 30 deg W during the 1969 Atlantic Expedition of the research ship Meteor. Air samples were analyzed by the gas chromatographic method of Bock and Schuetz. The N20 mixing ratio in air shows low values for air masses originating from West Africa, suggesting N20 sinks in these arid areas. The N20 concentration in surface water is 1.5 to 3 times higher than the equilibrium from the air, indicating that this part of the Atlantic Ocean is a source for atmospheric N20. In deeper layers of the ocean, there is an indication of N20 destruction.
Source: 1

#1428

Junge, C., W. Seiler and J. Hahn. "CO- und N2O-Kreislauf in der Atmosphaere." (CO and N2O circulation in the atmosphere). Umschau (Frankfurt), 71(14): 528 (July 1971).

Results of studies of atmospheric carbon monoxide and nitrous oxide circulation are reviewed. Atmospheric trace gases such as CO, N2O, methane and hydrogen show striking similarities regarding circulation, concentration (0.0000001 - 0.00001 ppm), and life, which may range from one to a few years. In addition, they are too inert to undergo chemical reactions within the limits of the troposphere. Soil bacteria are the chief producers of N2O, and

small proportions are produced by oceans. Concentration measurements revealed a rapid decrease in N2O concentration with altitude. The decomposition of N2O takes place chiefly over arid areas, probably due to microbial processes. Surface waters in oceans contain CO in very high concentrations compared to the concentration in the atmosphere, which indicates that oceans represent a major source of CO, largely equivalent to anthropogenic CO production. Soil microbiological processes may be responsible under certain conditions for both the formation and decomposition of CO. The rapid decrease in the CO concentration above the tropopause, probably due to oxidation by water radicals, suggests that the elimination of CO takes place predominantly in the stratosphere.
Source: 1

#14
Kadota, M. "Air pollution and trees: the creation of urban woods." J. Japan Soc. of Air Pollution, 1(6): 1-12 (1971).

Citing absorptive and filtering effects of trees (via brief literature review), author calls for planting of "urban woods" on a large scale to maintain balance between CO_2 and O_2 and also to regulate urban climate and help purify and filter air.
Source: 1

#1102
Kadota, M. "Taiki osen to toshi-rin - Shokuba no mawari no mini ryokuchi." [Air pollution and urban woods - Miniature green areas around working places]. Rodo no Kagaku (Dig. Sci. Labor), 27(23):77-81 (Feb.-March 1972).

The effectiveness of green areas examined from the standpoint of psychology, natural sciences, and environmental health. From the environmental hygiene point of view, green areas attenuate the severeness of winter wind, summer dusts, sand, and tide. A green area can act as a noise buffer and as a natural oxygen emission source, and can be effective for diluting and diffusing polluted air on days when the wind is weak and the smog is heavy. It has also been recognized that a green area functions as a dust filtering object. Trees that are strong against sulfur dioxide or oxidant, and therefore suitable for a city green area include camellia or ilex trees or any other that are evergreen and have thick leaves. The design of miniature urban green areas, the methods of maintenance of soil, fertilizing, and protection of trees are discussed.
Source: 1

#1082
Kadota, Masaya. "Ozone ni yoru shokubutsu no higai." (Damage to plants by ozone). Shokubutsu Boeki (Plant Prot.), 27(6):229-232 (June, 1973).

Ozone can absorb ultraviolet radiation and thus protect plants. However, excessive ozone caused by smog can cause plant damage including defoliation, growth inhibition, decreasing fruit, chlorosis, necrosis, and spots. Leaves just prior to maturation are most susceptible to ozone. Species susceptible

to ozone is discussed. Ozone damage is smaller when the surface is dry and larger on leaves not receiving much sunshine. To determine ozone damage, it is convenient to determine the chlorophyll content in leaves; discoloration of leaves and palisade parenchymatous damage should be taken into consideration. When other pollutants coexist with ozone, it is difficult to confirm the origin of plant damage. Methods to lessen ozone damage include spraying of vitamin C, supplying sulfur to plants which demand large sulfur nutrition, and planting a strong plant species around a weak one.
Source: 1

#1096
Kadota, M., and K. Ohta. "Honpo-san shokubutsu no kaki ni okeru ozon higai no kyojaku toku ni ozon-gai ni kansuru yagai chosa no hojo to shite no zanteiteki higaido risuto." (Ozone sensitivity of Japanese plant species in summer, with special reference to a tentative sensitivity grade list for applying to field survey on ozone injury). Text in Japanese. Taiki Osen Kenkyu (J. Japn Soc. Air Pollution), 7(1):19-26 (1972).

Over 30 species of Japanese plants were exposed to 0.25 ppm of ozone for 5 hours daily to determine their ozone sensitivity and to supply data for a sensitivity grade list for use in field tests on ozone injury. Injury due to ozone was usually restricted to the mature leaves. The initial lesion of the leaf was in the palisade cell layer, sometimes extending to the spongy cell layer and to the underlayer. Injury grade was assessed on the basis of the periods required to produce incidental spot like lesions on the upper surface of about 5% of the leaves. A tentative sensitivity grade list is present for over 70 plant species.
Source: 1

#811
Kadota, M., and H. Yamada. "Ozon no akamatsu oyobi kuromatsu ba ni oyobosu eikyo." (Effect of ozone on some pine needles). Text in Japanese. (Proceeding of the Japan Society of Air Pollution, Annual Meeting, 11th, Tokyo, Japan, 1970.) Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):158 (1970).

Ozone was diluted by a given amount of air and introduced into small test boxes in which were placed branches of red and black pines. Tests were usually carried out between 9:30 and 15:30, adding fluorescent light to create at least 10 Klux on rainy or cloudy days. Visible damage and chlorophyll a and b were measured by photocolorimetry every 30 min during the test period. In the experiments carried out in March and April, the ozone concentration and the time of the first visible damage on pine needles from the previous year showed a linear relationship. But the experiments on first year leaves (new leaves) in June and July showed considerable fluctuation due to the vigorous growth and individual biological pattern of development in young leaves in summer. Setting aside the age of pine needles, the red pines showed the first visual damage in approximately 20 to 25 hrs. 0.2 ppm ozone in spring, but the same damage was observed in two to five hours in summer. Ozone seems to have caused a considerable decrease in chlorophyll by the time visual damage was effected. The black pine showed slightly more endurance than the red pine.
Source: 1

#492
Kadota, M., H. Yamada, and K. Ohta. "Ozon sesshoku ukken kara mita sushu no shokubutsu no taisei no sai." (Ozone injury to some plants). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):141 (1971).

Eighteen plants were subjected to tests of their resistances to ozone in a laboratory. The ozone was generated by a small generator, and air was introduced to keep a constant concentration at 0.2 ppm in the contact room. The contact of the plant and ozone-containing gas was performed at a maximum of5 6 hr/day during the hours of 9:00 in the morning to 4:00 in the afternoon. The formation of initial smoke spots on the plants were checked every 30 min during the course of the experiment. If an initial smoke spot was found, the plant was removed from the contact room and the degree of injury was investigated after 1-2 hours, Results showed that herbaceous plants had the weakest resistance, deciduous plants had more resistance, and evergreen broad-leaved plants had the strongest resistance.
Source: 1

#1106
Kahn, H. L., F. J. Fernandez, and S. Slavin. "The determination of lead and cadmium in soils and leaves by atomic absorption spectroscopy." (Presented at the Meeting on Agronomy and Environmental Quality, New York, August 1971). At. Absorption Newslett., 11(2):42-45 (March-April 1972).

Lead and cadmium were determined in soil samples taken from various locations near highways and gas stations, after both acid and acetate extractions, and in leaves after digestion in nitric acid. For soils, acid extraction gave consistently higher results than did acetate. The lead levels in all soils and leaves were sufficiently high that a standard instrument with a conventional burner could be used. The cadmium levels were marginal, and it proved desirable to improve sensitivity by employing a Delves micro-sampling system in conjunction with the burner. Lead in leaves can be determined directly, without prior dissolution, with the Delves system. The distribution of lead in leaves was not homogeneous.
Source: 1

#1122
Kamada, S., M. Yanai, and H. Yunomura. "Dai I poh Alyusan gas sesshokoo johken oyobii goosa no seiikoo jiki ni yoloo higai shohjoh no sai." (Studies on the injury of rush plant by sulfur dioxide gas). Text in Japanese. (Proceedings of the Japan Society of Air Pollution Annual Meeting, 10th, 1969.) Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1): 131 (1969).

A study of the relationship between rush injury and sulfur dioxide was performed, since it is suspected that peculiar injury of rush at its latter growth period at Koorashiki area is related to sulfur dioxide,the main pollutant of nearby industrial area. Its injury starts at very low con-

centrations of sulfur dioxide when 0.08 to 1.0 ppm of sulfur dioxide causes discolored dots which become similar to 'natural injury' after a couple of days, when contacting continuously with approximately 0.3 ppm sulfur dioxide its injured portions becomes longer. Injury starts earlier and its damage is bigger at the latter part of the growth period (the latter part of May) than at the middle period (the middle and the latter part of April). The extent of injuries increases for the stalks offshooted earlier when they contact the gas at the same time and for the stalks offshooted at the same time, contacted with the gas at later part of the growth period.
Source: 1

#1133
Kamieniecki, F. "Z. badan nad zasiegiem wplywu przemyslowego zanieczyszczenia powietrza na lasy." (The range of the influence of the industrial air pollution on forests). (Presented at the French Polish Symposium on Air Pollution Control, Paris, France, Nov. 1969) English translation from Polish of: Ochrona Powietrza, 4(4(18)):37-42 (1970).

Damage to forests was attributed to industrial sulfur dioxide pollution. An inventorial study, based on external characteristics easily recognizable in the field, revealed that 3% of the forests in Poland are threatened or damaged. The projected increase of air pollution will bring the total area to 6% by 1985. To reverse this trend, major reforestation efforts and research aimed at pollution control are mandatory.
Source: 1

#205
Kamprath, E. J. "Possible benefits from sulfur in the atmosphere." Combustion, 44(4):16-17 (Oct. 1972).

Sulfur is one of the essential elements required for plant growth. The main supply of sulfur in top soils is organic sulfur from the microbial decomposition of the soil organic matter. However, with continued cropping and higher crop yields, this supply becomes depleted and is not renewable. Another source of sulfur is the sulfur dioxide present in the atmosphere, most of which results from the burning of sulfur-containing fuels. The SO2 can be utilized by absorption through leaves; cotton plants grown in a greenhouse absorbed 40% of their sulfur from that atmosphere containing 0.01-0.05 ppm SO2. The amounts of sulfur brought down by precipitation and added to the soil vary depending on the industrial activity of the area. In Minnesota, for example, the annual addition of sulfur to the soil ranged from 100 lbs/acre in Minneapolis to 5 lbs/acre in rural areas. In certain areas, this additional sulfur can supply needed sulfur to crops. However, high concentrations of SO2 can damage plants. The implementation of pollution controls to remove sulfur from fuels would reduce the amount of sulfur in the atmosphere and that brought down by rainfall. Where concentrations of SO2 in the atmosphere are not detrimental to humans or vegetation, sulfur-containing fuels can have a beneficial effect on crop production. Where soils are deficient in sulfur, application of 10-25 lbs/acre of sulfur from fertilizer sources is required for optimum crop yields.
Source: 1

#1195
Kanagawa Prefecture (Japan), Secretariat of Countermeasures to Environmental Pollution. "Konchu seitaikei ni oyobosu taiki osen eikyo ni kansuro chosa kenkyu (chukan hokoku)." (An interim report on theinvestigation of the effects of air pollution on the ecological system of insects). Text in Japanese, 4 p. (Dec. 1973).

To examine the effects of air pollution on the ecological system of insects, the kinds and number of insects caught by light traps set up at 23 points distributed in Kanagawa Prefecture were recorded on every 5th and 20th day of the 5-month period from May to Sept. 1973. The most numerous insects caught were moths, amounting to 9465 of about 400 species (almost most numerous in species), among less than 1000 species which exist in Prefecture. The points where the number of species was the largest, relatively large, medium, relatively small, and small was, respectively, 3, 5, 5, 8 and 2. A method of establishing an index insect is now under discussion. The index of multiplicity of the specimen corresponds fairly well to the concentration of environmental aerial pollutants. Statistical methods for determining indexes of air pollution by biological indicators are given.
Source: 1

#1181
Kanagawa Prefecture Office (Japan). "Seibutsu shihyo ni yoru taiki osen eikyo no chiakai najoka M kan suru chosa kenkyu - chukan dai 1 po." (Studies on the local evaluation of the effects of air pollution by biological index. Interim Report I. On the evaluation of air pollution by remote sensing). 10 p. (Dec 1973).

The amount of arboreal activity locally affected by air pollution and numerical data obtained by transformation of aerial photography of local arboreal activity were compared to determine a biological air pollution index. The remote sensing technique used in Japan is described. The investigation was carried out in Sept. 1973 and Oct. 1972 in 16 districts of Kanagawa Prefecture on three evergreen trees and three deciduous trees easily affected by air pollution. A noticeable correlation occurred between arboreal activity of zelkova, ginkgo castanopsis, and mixed flora and the photographic density and their ratios.
Source: 1

#1142
Kanagawa Prefecture Agriculture Experiment Station (Japan). "Jumoku ni taisuru taiki osen no eikyo - Gairoju-yo no jukinzoku." (The effect of air pollution on plants - heavy metal contained in street trees). Kanagawa-ken Taiki osen Chosa Kenkyu Hokoku (Tech. Rept. Air Pollution Yokohama-Kawasaki Ind. Area), 14:75-86 (Feb. 1972).

Leaves of street trees in Kawasaki and Yokohama cities were collected in 1967. Heavy metals were measured including iron, manganese, zinc, copper, nickel, lead, chromium, and cadmium. The average concentrations of metals in leaves were 862 ppm (iron), 69 ppm (manganese), 90 ppm (zine), 24 ppm (copper), 9 ppm

(nickel), 23 ppm (lead), 7 ppm (chromium), and 0.9 ppm (cadmium). The heavy metals except for cadmium were contained more in trees in industrial areas than in trees in commercial or residential areas. There was a mutual relationship between insoluble substances stuck to leaves and the content of heavy metals in the leaves. A change of the content of heavy metals in leaves according to the month occurred; the new leaves of May did not contain as much as previous months, but after July or August the value showed an increase.
Source: 1

#1163
Kanagawa Prefecture Agriculture Experiment Station (Japan). "Jumoku ni taisuru taiki osen no eiyko - Gairoju-yo no fusso ganryo." (The effect of air pollution on plants-the fluorine content in street trees). Kanagawa-ken Taiki Osen Chosa Kenkyu Hokoku (Tech. Rept. Air Pollution Yokohama-Kawasaki Ind. Area), 14:87-92 (Feb 1972).

Leaves of street trees in Kawasaki and Yokohama cities were collected in 1967. The maximum value of the content of fluorine in the leaves was 1653 ppm, the minimum value was 22 ppm and the average value was 135 ppm. There was a regional difference in the fluorine content in leaves between an industrial area and a commercial or residential area. The fluorine content in leaves of an industrial area and a commercial or residential area was in the ratio 10 and 2 or 3. There was a mutual relationship between the value of sedimented dust in the air and the content of sulfur oxides in air and the content of fluorine in leaves. The relationship between the fluorine content and the sulfur content in leaves and the relationship between the fluorine content in leaves and insoluble substances stuck to the leaves was not clear. The fluorine content in the soil was between 108 and 504 ppm, and the average content was 240 ppm.
Source: 1

#1141
Kanagawa Prefectue Agricultural Experiment Station (Japan). "Taiki osen busshitsu ga engei sakumotsu nado ni kansuru kenkyu seisekisho (I)." (Cooperative studies on the effects of air pollutants on garden plants (I)). Text in Japanese, 136 p. (Feb. 1972).

Cooperative studies were conducted on the general effect of air pollution throughout Kanagawa Prefecture. Studies included periodical measurement of pollutants, plant damage examainations, evaluations of plant indicators, and measurement of sulfur, heavy metals, and fluorine. Gingko and pine were chosen as general plant indicators, and as area representatives, mulberry leaves from the north, pear and grape leaves from the center, and orange leaves from the western part of the Prefecture were selected. Gingko and pine samplings in Kawasaki were extremely unhealthy in appearance, compared to those from suburban Kawasaki, and the northern, central, western, and coastal areas. The S content in leaves was extremely high in Kawasaki, and a particularly high ratio of nonsoluble S was noted. In all categories of metals, samples from Kawasaki had the highest content but other than that, generally leaves from the western part of the Prefecture had high counts of iron, zinc, copper, nickel,lead, and manganese. The average

fluorine content in leaves was 135 ppm, 22 ppm minimum and 1653 ppm maximum. The differences by locations and tree specimens were extremely high. If the F index of leaves in the industrial area is considered to be 100, those in commercial, residential, and agricultural areas were less than 20-30. There was a correlation of 0.711 between F and S content of gingko trees. There was an extremely close correlation between the F content of leaves and the amount of settling particles and sulfur oxides concentration in the air. The F content in the leaves increased with the season, at the peak, it reached three to eleven times the amount in new leaves in May.
Source: 1

#1193
Kanagawa Prefectural Agricultural Experimental Test Station (Japan). "Taiki osen no jumoku ni oyobosu eikyo narabi ni ryokka jumoku ikusei ni kansury kenkyu." (Studies of the effects of air pollution on trees and on green tree growth). In: The 1972 Investigation of Air and Water Pollution on the Human Health by the Chiba Prefectural Government Dept. of Hygiene, Report 15. 182-196 (Feb 1973).

Trees in six parks and green areas in the Kawasaki area were investigated from the coastal area to inland, to see the effects of pollution on trees. Gingko trees and pasania were compared, and in all areas, gingko was free of insect damages, but pasania trees were damaged by several kinds of parasites.

Generally, the sulfur oxides content in the leaves decreased as the distance from pollution sources increased. Generally the content ratio was higher in gingko, and in areas close to emission sources, the level of sulfur content was twice as high in gingko as in pasania. The farther away from emission sources, the greater was the growth rate for pasania, but a reverse tendency was noted for gingko. However, the size of the leaves were larger for gingko in areas farther away from emission sources. The relationship between the distance from emission sources and the degree of damages on pasania trees (discoloration of leaves, dead branches, and abnormal growth could not be grasped clearly, but pollution and parasite seemed to have some relationship. The soil's chemical composition, general appearance and growth, growth rates, leaf size, number of remaining leaves, extent of damages, state of insect damages, and sulfur content in leaves are presented in tables.
Source: 1

#206
Kanagawa Prefectural General Agricultural Research Inst. "Baijinchu no kinzoku seibun no jumoku e no eikyo." (The effects of metal components in dusts on trees). In: The 1972 Investigation of Air and Water Pollution on Human Health by the Chiba Prefectural Government, Department of Hygiene, Rept. 15. 204-210 (Feb 1973).

The annual average of settling particles in the central Kawasaki is 41.3 tons/sq km/mo, of which 22.7 tons are nonsolubles. February, May, and July are the dustiest months, and the average reaches 70 tons/sq km/mo, and a maximum of 40 tons are nonsolubles, especially toward summer. Three kinds of evergreen and three kinds of deciduous trees were examined to see the

metal components in the dusts and their effects on leaf growth in various parks of Kawasaki. The metal content was the highest in a park in the industrial area, followed by parks in the commercial and residential areas. The content of iron and manganese in the commercial and residential areas was 40-50% of that of the industrial area, and zinc, lead, copper, and nickel were 70-80% of the industrial area. Generally, the difference between commercial and residential areas was small, but those of Cu and Ni compositions were slightly greater, and there were no geographical differences at all for cadmium. The metal adsorption on tree leaves is difficult to estimate, but monthly averages may be 400-1600 mg/sq m in the industrial area, 200-1400 mg/sq m in the commercial area, and 100-800 mg/sq m in the residential area. The amount of adsorption seemed to be the greatest for gingko trees among the deciduous species, and for the coral tree, pasania, and sweet oleander among the evergreens. The highest metal content in washed leaves is Fe, followed by Mn, Zn, Pb, Cu, Ni, and Cd. The Mn and Zn content are about 10% of Fe, and the Pb, Cu, and Ni contents are about 10% and the Cd content is about 1% of Mn and Zn. The ratio of Fe in the industrial area is much greater than that in other areas. In the industrial area, the growth rate of the young leaves of zelkova and gingko trees seemed to be much smaller than those of the two other areas, especially between spring and summer. The growth rate was the highest in the residential area. There was a definite correlation between the tree damage and the metal components in leaves. Complex effects of sulfur dioxide and other gases and the metal components in settling particles must be studied further.
Source: 1

#1205

Kanagawa Prefectural General Agricultural Research Inst. "Taiki osen busshitsu ga engei sakubutsu ni oyobosu eikyo." (The effects of air pollutants on horticultural and agricultural produce). In: The 1972 Investigation of Air and Water Pollution on Human Health by the Chiba Prefectural Government Department of Hygiene, Report 15, 197-203 (Feb 1973).

At 16 monitoring locations in Kanagawa prefecture, settling particles, sulfur oxides, nitrogen oxides, chlorine ion were measured in dust jars and by alkaline filter paper. The yearly average of dusts for the total prefecture is 5-6 tons/sq km/mo whereas in the Yotsuya district of Kawasaki, the yearly average reaches 22.7 tons/sq km/mo. The annual average of SO_x is 1.8 mg/100 sq cm/day in Yotsuya in Kawasaki, 4 mg/100 sq cm/day in other districts in Kawaski, and in other cities, 0.2-0.3 mg. The NO_x averages are relatively high in Kawasaki and central area of the prefecture, and 0.1 mg/100 sq cm/day in suburban cities. The level of Cl ions relatively high west of the prefecture, and in all cases, an increase was noted between summer and fall, clearly influenced by the sea breeze. As plant indicators, gingko and pine trees were selected and the leaves were sampled near 16 monitoring locations, and sulfur contents were analyzed. The trees were unhealthy and deformed in the industrial areas of Kawasaki, but in other areas, no extraordinary damages were noted. The sulfur content in gingko leaves was the highest in the Daishi district of Kawasaki and was more than 1%. In other areas, it ranged from 0.24 to 0.6%. The S content in pine trees was much smaller, ranging between 0.1 and 0.3% even in Yotsuya, Kawasaki. Fumigating experiments of various produce showed that an exposure to 2 ppm sulfur dioxide for 4 hrs changed the color of tea leaves and the leaves eventually dropped. Relatively visible damages appeared on eggplants, persimmons, grapes, and pears with an exposure of 1 ppm SO_2 for 3 hr, on tomatoes and tea with 2ppm for 3-8 hrs, and lettuce, plums, oranges, and mulberry leaves were relatively strong.
Source: 1

#1208
Kanagawa Prefecture General Agriculture Research Lab., (Japan). "Kokagaku kogai no yoru nosakumotsu higai." Text in Japanese. Kanagawa-ken Taiki Osen Chosa Kenkyu Hokoku (Tech. Rept. Air Pollution Yohohama-Kawaski Ind. Area), 15:255-258 (February 1973).

After a photochemical smog warning issued on April 29 in Sagamihara, Zama, Atsugi, Yamato, and Kawasaki, 122 people developed bodily damages in Kawasaki and Yokohama. Plant damage between May 2 and 8 soon after photochemical air pollution occurred in eight wards where crops such as Japanese leek, spinach, turnip, radish, and green soybean were damaged. Winds blowing southeast to south with a velocity of 2 to 3 m/hr, clear weather, high temperatures, and less and 2 m visibility were common meterological parameters. The oxidant concentration reached the highest point between 1 and 2 pm. Hiratsuka City was severely damaged in the middle part of the city where many Japanese leek sapling turned white in the tip of the leaves and withered. Brown spots appeared between the veins of green soy beans and necrosis often occurred. These crop damages are presumably due to repeated exposure within short time period to oxidants of high concentration. The primary meteorological variable in Hiratsuka City was a northeastern land breeze until 11 a.m. which shifted to a southwestern sea breeze in the afternoon. Visible damages done on the crops increased on the second day after exposure. When exposures last for 3 to 4 hr at the level of 0.15 ppm, for 2 to 3 hr at the level of 0.2 ppm, or for 1 to 2 hr at the level of 0.25 ppm, the rate of damages increases.
Source: 1

#1221
Kaneda, K., R. Sugai, Y. Fujieda, and E. Abe. "Fukkabutsu ni yoru taikiosen to shokubutsu eikyo." (Atmospheric pollution by fluoride and its influence on plants). Text in Japanese. (Presented at the Japan Society of Public Health, General Meeting, 31st, Sapporo, Japan, Oct. 25-27, 1972.) Nippon Keshu Eisei Zasshi (Japn. J. Public Health), 19(10):423 (Oct. 1972).

Atmospheric fluoride concentrations were measured from May 1969 to March 1972 for each month by the limus and alkali filter paper methods. The growth of potted gladioli at 11 spots near two factories (phosphate fertilizer and an aluminum refining factory)was measured in 1969, of rice at 30 spots in 1970, and of cedar trees at 38 spots in 1971 Gladioli growth was measured at 10 spots; at two spots with high fluoride concentration, the leaf color change, retardation of height and number of leaves, and other significant differences were observed. At 1 km from the factory, the plant growth rate decreased. Cedar trees checked at 37 spots except for nine contrasted spots, revealed some damage. Some correlation was found between atmospheric fluoride concentration and more fluorine quantity in the leaves.
Source: 1

#1233
Kano, F. "Nenkin no seiri kino ni oyobosu okishidanto no eikyo." (The effects of oxidants on the physiological function of the slime mold). Text in Japanese. Japan Society of Air Pollution, Proc. Symp. Japan Soc. Air. Pollut., 13th, p. 226, Nov. 7-9 (1972) Paper 174.

The effects of oxidants on myxomycetes were studied. Physarum polycephalum was chosen as a test species, and the movements under the influence of oxidants (mainly ozone) were studied. The test material was placed in a glass exposure chamber, and ozone was supplied. Ordinarily, the cycle of the movement of myxomycetes consists of a long stride of the tip part and a short retrieval by the back. Advance is made by the difference of the two steps. Under the influence of ozone, the cycle reversed and the tip retreated. The gell portion thickened. The membrane of myxomycetes seemed to be extremely sensitive to ozone.
Source: 1

#1234
Kano, F. "Nenkin no seiri kino ni oyobosu okishidanto no eikyo -dai 2 ho." (Effects of oxidants on physiological function of a slime mold, Part II). Text in Japanese. (Presented at the Japan. Society for Air Pollution, Annual Meeting, 14th, Fukushima, Japan, Nov. 6-8, 1973.) Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):431 (Oct. 1973).

By using the double chamber method, the pressure required to arrest the protoplasmic streaming of slime mold. Physarum polycephalum was measured to determine the motive force influenced by the exposure of the slime mold to ozone at 0.3-0.5 ppm. The change of respiration of the slime homogenate by the exposure of the slime mold to ozone was measured by oxygen electrode method. The motive force of the slime decreased by exposure to ozone and increased at the cessation of the slime and the consumption of oxygen after addition of the substrate succinic acid increased with exposure to ozone. The coefficient of metabolism of internal respiration was 9.5 and 13.6 microlitre/mg/hr, respectively, for the control and the ozone, exposed slime homogenate. After addition of the substrate, the addition of ADP made the respiration a little higher; however, the curve showing the relative concentration versus time was not seen, suggesting the absence of control ability of respiration. The reversible decrease of motive force of protoplasmic streaming by ozone exposure would be due to the disturbance of the glyolytic system. The effect of ozone on the slime mold were discussed from the connection or respiration and glycolysis.
Source: 1

#1437
Kanto Regional Environmental Protection Headquarters (Japan), Air Pollution Section. "Kokagaku sumoggu ni yoru shoku butsu eikyo chsa." (Investigation of plant influence by photochemical smog). Text in Japanese. In: Report of the 1973 Joint Survey on Photochemical Smog in Tokyo and Three Neighboring Prefectures, p. 105-175 (April 1974).

Plant damage due to oxidants was investigated on the third and fifth day of a period of high oxidant concentrations. Spinach Swiss chard, morning glory, taro, welsh onion, peanut, and maize plants were used as plant indicators. Salting green, Chinese cabbage, tobacco, turnip, Japanese radish, carrot, burdock, and soya plants were used as sub-indicators. Damage critera were: 0 - no damage; 1 - less than 10% of the surface damaged on the most severely damaged leaf; 2 - from 10 to 30% of the surface damaged; and 3 - more than 30% of the surface damaged. Field notes and photographs were taken.
Source: 1

#1438
Kanto Regional Environmental Protection Headquarters (Japan), Air Pollution Section. "Showa 48 nendo itto sanken kokagaku sumoggo kyodo chosa hokokusho no gaikyo." (Outline of the report of cooperative investigation of photochemical smog in the metropolis and three prefectures in 1973). Text in Japanese. Preprint, 4 p. (April 1974).

On June 23 and July 30, plant damage due to high oxidant concentrations was studied in Tokyo and the surrounding area. Damage appeared on many plants and consisted of bleached spots and necrosis on part or all of the leaf surface and specific silvering and bronzing on the lower surface of relatively unmature leaves, the former due to ozone and the latter to peroxyacetyl nitrate. Damage on June 23 occurred mainly in Tokyo and Kanagawa Prefecture. On July 30, damage occurred only in Saitama Prefecture. Accumulated damage from July 15-18 occurred in Tokyo and the three Prefectures. The area of plant damage coincided almost completely with the area plotted by oxidants at a concentration level of five or more.
Source: 1

#1439
Kanto Regional Environmental Protection Headquarters (Japan), Air Pollution Section. "Showa 49 nendo kokagaku sumoggu kyodo chosa oyobi kokagaku sumoggu ni yoru shokubutsu eikyo chosa ni tsuite." (The plan of a cooperative investigation of effects of photochemical smog on plants in 1974). Text in Japanese. Preprint, 5 p. (April 1974).

The occurrence of photochemical smog damage to plants in the area of Tokyo and three Prefectures in the southern Kanto district now extends to northern Kanto. The effects of smog on plants in Ibaragi, Tochigi, and Gunma Prefectures were studied. Plants were studied from the end of June to early July and in the middle of August at nine points on Ibaragi, 12 in Tochigi, nine in Gunma, 12 in Saitama, 14 in Chiba, 10 in Tokyo, and 12 in Kanagawa. Plants studied include taro, maize, welsh onion, peanut, soya, spinach, Chinese cabbage, Swiss chard, turnip Japanese radish, and morning glory.
Source: 1

#812
Karpen, D. N. "Ozone and sulfur dioxide synergism: foliar injury to a ponderosa pine geographic race plantation in the Puget Sound region." Plant Disease Reptr., 54(11):945-948 (November 1970).

Chlorotic foliar spotting similar to the damage observed on ponderosa pine in the San Bernardino National Forest near Los Angeles has appeared in a stand of ponderosa pine near LaGrande, Washington, about 6.5 miles south of Seattle. Data are presented on the relative susceptibility to air pollution damage of each of the 10 geographic races represented in the stand. Based on characteristics such as needle retention, color, length and branch mortaility, the data may have future importance in the selection of pollution resistant ponderosa for reforestation purposes. In the Seattle area, concentrations of ozone and sulfur alone appear to be lower than that required to produce the chlorosis observed. It is hypothesized that the injury may be due to synergistic effects resulting from the interaction of sulfur dioxide with naturally occurring ozone.
Source: 1

#493
Kato, T., and S. Tanaka. "Sugikare gensho no genin kenkyu ni tsuite." (Studies on the causes for dying cryptomerias). Text in Japanese. (Presented at the Japan. Society for Safety Engineering, Seminar on Safety Engineering, 6th, Tokyo, Japan, Dec. 6-7, 1973) Preprint, Japan Society for Safety Engineering (1973).

Prevalence of tree damage, especially on cryptomeria, became conspicuous in the Toyama city suburbs between 1965 and 1970. Investigations were made for three years between 1970 and 1973 for the causes of tree damage. An area of approximately 10 sq km was divided into 1 sq km mesh, and the tree vitality was checked for each tree. The damages in some areas were mixed and in some areas group damages were noted. The trees with most advanced stage of damage were invariably infested by insects. Air pollution was investigated with regard to the total area, and especially on the direct lines between pollution sources (thermal power plant and industries) and the areas of concentrated damage. In the direct line from the thermal power plant to the forest, there were peaks of high sulfur dioxide concentration of over 0.05 ppm at 3 and 8 km. With such high concentrations, the relationship with tree deaths was possible. Direct effects may not exist, but it was clear that air pollution caused weakening of the trees and indirectly caused the infestation of insects. Automobile exhausts effects were investigated by measuring carbon monoxide, but there was no apparent effect.
Source: 1

#813
Katz, M., and A. W. McCallum. "The effect of sulfur dioxide on conifers." Proc. U. S. Tech. Conf. Air Pollution, Chapt. 8, p. 84-96 (1952).

Fumigation studies were undertaken to determine the effect of smelter fumes on a natural stand of Douglas fir and yellow pine and also on transported conifers. Trees in the natural stand were 25-30 years old, while the transplanted conifers were 3-10 years old. In addition, seedlings of yellow pine and Douglas fir from 1-3 years old were exposed to varying concentrations of sulfur dioxide. The conifers in their natural habitat were much more susceptible to sulfur dioxide in spring and early summer than in autumn and winter. The susceptibility paralleled the seasonal variations in physiologic activity of the leaves. The transplanted conifers were more susceptible to sulfur dioxide than trees in the natural stand, but the former were also extremely resistant during the period of the year when there was a virtual cessation in growth. Severely injured trees exhibited reduced growth for about three years following exposure, after which there was a substantial recovery. Seedlings were more susceptible than the older trees. The susceptibility of the species investigated, arranged in order of increasing resistance, was as follows: larch, Douglas fir, Engelmann spruce, white pine, yellow pine, cedar, lodgepole pine, silver fir, and white fir. Two forms of injury were recognized: acute and chronic. However, no evidence was found to support the theory of invisible injury. When high concentrations were not present, the fumigations were without toxic effects. It is concluded that sulfur dioxide will not injure vegetation if ground concentrations higher than 0.3-0.5 ppm do not occur.
Source: 1

#207
Kaudy, J. C., F. T. Bingham, R. C. McColloch, G. F. Liebig, and A. P. Vanselow. "Contamination of citrus foliage by fluorine from air pollution in major California citrus areas." Proc. Am. Soc. Hort. Sci., 65:121-127 (1954).

As a preliminary phase of an investigation of the effect of fluorine on citrus growth, the extent of fluorine contamination in citrus foliage was determined. Leaves from approximately 130 citrus groves, collected in both heavily polluted areas and areas far removed from pollution, were analyzed for fluorine. Citrus leaves from the Coachella Valley of Riverside County, and from San Diego, Ventura, and Tulare counties disclosed concentrations of 1 ppm F or less. Leaves collected in industrialized areas disclosed values up to 211 ppm F. The greatest fluorine accumulation was evident in leaves from the San Bernardino Valley, San Bernardino County, especially from the vicinity of Fontana, where a steel plant is located. Significantly elevated accumulations were also found in leaves from the Los Angeles area, presumably as a result of emissions from aluminum, ceramic, phosphate, and chemical plants. Elevated fluorine values were not associated with any visible damage to the trees. Sampling of leaves of 12 groves over a 9-month period disclosed a maximum accumulation of fluorine during the summer and fall months. Foliar concentrations of fluorine increased very little, once the winter rains began.
Source: 1

#1226
Kauf, H. "Ueber Luftverunreinigungen bedingt durch die Lebenstaetigkeit von Mikroorganismen." (Air pollution caused by microorganisms). Angewandte Meteorologie, 4(8-10):250 (November 1963).

Air pollution is usually considered to be a result of emissions from industrial processes. However, it seems to be important to point out that other factors, such as the production of toxic or unpleasant gases by microorganisms, can also be a major contributor to air pollution.
Source: 6

#338
Kauranen, P., T. Jaakkola, and J. K. Miettinen. "Stable lead and radiolead (210PB) in the 'Artic' food chain." In: Radioactive Foodchains in the Subartic Environment. (Annual Report). Helsinki Univ. (Finland), Dept. of Radiochemistry, AEC Grant AT (30-1) 3446, Paper 24, 6 p. (August 1969).
CFSTI: NYO-3446-13

The concentrations of stable and radioactive lead in the arctic food chain were determined. Lead was measured by an atomic absorption spectrophotometer. In lichen samples from Lapland, the radiolead concentration was slightly higher, and the stable lead concentration significantly lower than in samples from southern Finland. The specific activity of lead in lichen from Lapland is very high, over 1000 pCi/mg; in southern Finland, the specific activity is 300 pCi/mg. In reindeer samples, specific lead activities between 700 and 1000 pCi/mg were found. Results from human samples indicate that the average stable lead concentration of blood is about the same in Lapps and in southern Finns; the radiolead concentration in the Lapps is 2.5 times higher. This is a consequence of the higher specific activity of lead in the artic food chain, lichen-reindeer-man. The average specific activity of lead in human blood was 47 pCi/mg in Lapps and 20 pCi/mg in southern Finns. It seems that lichen is the source of the high specific activity lead in the arctic food chain, and that the lead gradually become diluted with less active lead from other sources.
Source: 1

#1440
Kawamata, E. and K. Ashikawa. "Tokyo kokagaku sumoggu no shokubutsu higai ni kansuru chosa kenkyu; 4. kaju ni taisuru taiki osen no eikyo." (Investigation and studies on plant damage due to Tokyo photochemical smog. Part IV: Effects of air pollution of fruit trees). Tokyo-To Nogyo Shikenjo Kenkyu Nenpo (Annu. Rep. Tokyo Met. Agr. Exp. Sta.), 1972:4 (Oct 1973).

In order to confirm the symptoms of pear trees which appeared in 1971, aqueous solutions of sulfuric, nitric and hydrochloric acids of concentrations of 0.1, 0.2, 0.5, 1, 2 and 5 N were respectively sprayed on pear trees. It was observed that (1) sulfuric and hydrochloric acid caused chlorosis on leaves three - four days after the spray even at the concentration of 0.1 N and they made brown lesions with the transparent center due to burning and peripheral chlorosis at 0.2 N, and (2) nitric acid gave brown-colored lesions on the leaf surface increasing in area with the increase of concentration from 0.1 N. At 1 N the center of the lesion became transparent due to burning.
Source: 1

#494

Kay, E. "An inquiry into the distribution of fluoride in the environment of Garrison, Montana." Fluoride, 7(1):7-31 (Jan. 1974).

In the fall of 1971 and 1972, the extent and severity of fluoride contamination in the vicinity of Garrison, Montana was determined. Assays of the fluoride content of indigenous flora and fauna were utilized to establish the effectiveness of the air pollution control equipment of a fluoride-emitting industrial facility. Vegetation samples included forage, shrubs, coniferous and deciduous tree species, as well as various species of small mammals in a directional pattern throughout the study area were analyzed for fluoride and compared with control samples collected throughout western Montana. Analysis by individual species allowed comparison of the ratio of fluoride accumulation between species. Fluoride levels in vegetation and small mammals were also correlated. Isopol maps of fluoride concentrations in vegetation were constructed. Wide differences between different species were observed. Fluoride concentrations in different species were compared and presented graphically.
Source: 1

#814

Kazantseva, E.N. "Assortments of gas-resistant lawn grasses." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects and Symptoms of Air Pollutes on Vegetation: Resistance and Susceptibility of Different Plant Species in Various Habitats, In Relation to Plant Utilization for Shelter Belts and as Biological Indicators, M.Y. Nuttonson (ed), Vol 2, Silver Springs, Md., American Institute of Crop Ecology, p. 50-55 (1969).

Investigators concerning the gas resistance of lawn grasses were conducted at a Ural aluminum plant where fluorine pollution is present. Photosynthesis and water regimen were studied in meadow fescue, red fescue, Kentucky bluegrass, red top, and timothy grass. Damage was observed in early spring when the leaves were appearing. There was burn on the tips of the leaves; then spotting and blotching appeared. The damage increased and reached a peak toward the end of the growing season. The smallest percentage of damage was observed on meadow fescue, red fescue and Kentucky bluegrass, while the greatest damage was found on red top and timothy grass. Fluorine compounds decreased photosynthesis, water-holding capacity, and the quantity of free water. Slightly damaged species have a lower photsynthetic intensity, greater water-holding capacity, and more free water than the severelydamaged grasses. Meadow fescue, red fescue, and Kentucky bluegrass are recommended for industrial sectors with severe fluorine pollution. Red top, 'regneria,' Awnless bromegrass, and timothy grass are suggested for sectors with little pollution.
Source: 1

#566

Kazmierczakowa, R. and B. Rams. "Wplyw przenyslowych zanieczyszczen powietrza na zawartosc olowiu i cynku w wybranych roslinach leczniczych w rejonie olkuskim." (The effect of industrial air pollution on the content of lead and zinc in selected medicinal plants of the Olkusz region). Herba Pol., 20(4):373-378 (Dec. 1974).

Lead and zinc were determined by the dithizone method in the medicinal plants Hypericum perforatum L., Viola tricolor L., and Thymus serpyllum L. em. Fr. collected in the environs of lead and zinc smelting works and on an experimental plot in an agricultural site with clean air. The concentration of lead in the herb collected in the vicinity of smelting works and on the experimental plot was from 80 to 130 mg/kg of dry mass and from 4 to 9 mg/kg of dry mass respectively. The contents of zinc in the plant species studied amounted to a maximum value of 1300 to 2000 mg/kg of dry mass in the vicinity of the smelting works and to 100-500 mg/kg of dry mass in the experimental plot.
Source: 2

#1227

Keller, T. "Der Einfluss der Luftverunreinigungen auf den Wald im Lichte der neuesten Literatur." (Influence of air pollution on forests as described in recent literature). Schweizerischen Zeitschrift fuer Forstwesen, 4/5: 335-352 (April/May 1968). (Reprinted in Eidgenoessische Anstalt fuer das Forstliche Versuchswesen, 8:11-21 (May 1968).

It has long been known that forests have the potential to clean polluted air. This article describes this effect for the following pollutants: dust, aerosols, radio activity, and lead from auto exhaust. However, forests cannot filter the toxic gases which cause extensive damage, expecially to conifers. The physiological effects of SO_2 emissions are discussed. It was found that a concentration of 1 ppm SO_2 reduces the capability for assimilation within a few hours. In higher concentration, SO_2 causes acute damage. Other toxic gases such as chlorine, fluoride, and nitrous gases also have damaging effects on trees. Forests affected by air pollution have an increased sensitivity to frost, drought, and insects. Among the measures that can be taken in forestry are the following: selection of plants with high resistance to emissions (foliage trees usually being more resistant than conifers); fertilization (it has in some cases resulted in increased smoke resistance); and, functional arrangement of rorests and proper care.
Source: 6

#573

Keller T. "Bericht ueber die VII. Internationale Arbeitstagung Forstlicher Rauchschadensachverstaendiger, 7. bis 11. Sept. 1970 in Essen." (Report on the VII International Conference of experts on smoke damage to forest, Sept. 7-11, 1970, in Essen). Text in German. Schweiz. S. Forstwesen, 121 (12):905-911 (Dec. 1970).

The central European experts on smoke damage to forests meet at a conference every two years. About 50 papers were presented during the 1970 conference. These included a number of reports about the Ruhr area where, with a population density of 1240 inhabitants/sq km and with 250 automobile vehicles/sq km, home heating and traffic contribute substantially to air pollution. Good progress has been made in industrial dust removal. In the period 1964-68 the dust emission of the steel and ironworks in the Ruhr area was reduced from 180,000 to 110,000 tons per year. Considerable attention is given to the sulfur dioxide situation. A smog warning service is in operation, using the SO_2 concentration in the air as indicator. Pine and spruce trees in the vicinity of industrial areas show chronic damage including impeded growth, as evidenced by a reduction in annual rings. Experiments with planned exposure of plants to gaseous pollutants were described, including the effect of ozone on various deciduous trees in the form of necrosis. Ash trees proved to be the most sensitive ones in this respect, while maple and oak trees, exposed for eight hours to 0.25 ppm ozone, did not show any symptoms. Experiments reported include the exposure of twigs of various fir varieties to radioactive SO_2 gas. The absorption of the SO_2 was most intense in the needle tips. Aerial color photography for detection and isolation of diseased trees has shown that trees with external damage are easily discernible, whereas those with invisible physiological damage could be detected on the photographs.
Source: 1

#393
Keller, T. "Der jetzige Bleigehalt der Vegetation in der Naehe Schweizerischer Autostrassen." [The current lead content in vegetation growing in the vicinity of Swiss highways]. Z. Praeventivmed., 15:235-243 (1970).

The factors affecting the level of lead accumulated in cultures growing near highways travelled by automobiles are traffic density, season, the age of pine needles, the surface structure of the exposed plant organs, and the vertical and horizontal distance from the highway. In contrast, the lead content in the soil is hardly a factor, partly because only a small fraction of the lead compounds in the soil are absorbed by plant roots and partly because transport of lead within the plant is minimal. A large percentage of lead found in plants adheres to the surface, but this lead washes off only to a limited extent. The lead concentration of unwashed crops at a distance of 100 m from highways with heavy traffic was considerable; hay contained 2-8 ppm; leaf vegetables, 3-7 ppm; carrots, 2-3 ppm; fruit, 0.7 to 2.7 ppm; and cereals, 0.3-0.5 ppm. Conifers are an excellent air filter, and highways should be lined on both sides with a strip of evergreen trees and shrubs. Tetraethyl lead as an additive to gasoline should be replaced by safe substitutes, even though hitherto no actual harm has been caused to either plants, animals, or humans from lead emission from highway traffic.
Source: 1

#1441

Keller, T. "Zum Problem der verkehrsbedingten Bleirueckstaende in der Vegetation." (The problem of traffic-induced residues of lead in vegetation). Strasse Verkehr., 1: (1970).

The examination of live and dried moss from Sweden disclosed that from 1860 to 1968 the lead content of moss even in localities far removed from traffic increased from 20 ppm to 80-90 ppm, with the highest increase registered since about 1950. This is because the size of three-quarters of the emitted lead particles is less than 5 microns and thus remains suspended in the atmosphere to be distributed eventually over wide areas. The increase of lead in plants has been proven to be due to the emissions in automobile exhaust gases. Lower lead contents were found in conifer needles 6 m above ground than in needles growing 2 m above ground. For the most part, the lead remains in the roots or needles, only a minimal share is transportad by conifers. Another indication that the lead in vegetation comes from exhaust gases is the decrease in the lead content of vegetation with increasing distance from highways. Thus, hay harvested 10-49 m from a highway contained 5-19 ppm lead while hay harvested in a strip 50-100 m from the highway contained only 2-8 ppm lead. Swiss authorities contemplate setting 10 ppm lead as the maximal permissible level of lead in the dry fodder of domestic animals. The planting of hedgerows alongside highways is recommended as a protective measure against the contamination of vegetation with lead emissions.
Source: 1

#815

Keller, T. "Auswirkungen der Luftverunreinigungen auf die Vegetation." (The effects of air pollution on vegetation). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(6):130-136 (1971).

Generally two groups of air pollutants are distinguished when considering vegetation effects. Inert dusts can be taken by plants without injury; toxic gases, however, destroy them. Of all forms of vegetation the forest has the highest dust filtering capacity; one hectare of spruce forest binds about 32 tons of dust; 1 hectare of beech forest, 68 tons when the dust is washed off by rain, the filtering capacity is restored and the dust is mixed with the soil. Of the gases, sulfur dioxide is the most harmful. It is estimated that about 200,000 hectares of forest have been damaged in the German Democratic Republic by emission of SO_2. The long term maximum allowable emission conentration for SO_2 in Switzerland is 0.2 ppm, which still seems to be too high. The SO_2 which penetrates into the cells attacks the chlorophyll and causes chlorosis. It has been found that deciduous trees are much more resistant than coniferous ones. Through adequate fertilization the resistance of plants may be increased; through nitrogen fertilization growth is stimulated and injuries can be healed faster. However, through the higher assimilation,more pollutants may penetrate the plant organs. Further studies are needed to determine which one of these processes prevails.
Source: 1

#1000
Keller, T. "Die Bedeutung des Waldes fuer den Umweltschutz." (Significance of forests for the environment). Symposium - Bern, Switzerland, Schweizerische Zeitschrift für Forstwesen, 122(12):600-613 (1971).

Aside from its traditional functions such as, protection against floods, avalanches, etc., the forest has gained importance in controlling modern environmental threats: (1) The forest, by its existence, reduces dangerous emissions (pollution sources are rare in forests); (2) The forest regulates the water supply because it functions as a storage area. It also influences the water quality: runoff from forests is not enriched with phosphates and nitrates, unlike runoffs from agriculturally used land. Therefore, the forest does not contribute to the eutrophication of lakes; (3) The forest filters polluted air; (4) The forest helps in maintaining a biological diversity; and (5) The forest is an important element of the countryside and should be considered in environmental planning.
Source: 5

#13
Keller, T. "Effect of air pollution on plant life." Municipal Hygiene, 22(6): 1-22 (1971).

Only reference to sink function of vegetation is about binding of dusts like cement and coal ash dust. Article reviews types of damage to plants (mostly trees) from air pollutants. Citing "warning function" of plants, author calls for development of resistant species, forest fertilization to improve resistance, public recognition of the scope of the problem.
Source: 8

#894
Keller, T. "The importance of the forest for the protection of the environment." Schweizerische Zeitschrift fur Forstwesen, 122(12):600-613 (1971).

The destruction of the forests and the clearing and breaking of ground in the Middle Ages in the Alps and Lower Alps had as a consequence considerable upsets in the natural balance and caused numerous inundations. These circumstances motivated the working-out of a forest legislation. The law of 1902, considered perhaps deservedly as the first Swiss statute in favor of a protection of the environment assured the conservation of the wooded area and forced the renouncement of economic measures that presented a danger to the environment.

Aside from traditional functions of production, of protection (avalanches, stone falls, etc.) and of recreation the forest performs the following tasks in the framework of environmental protection:

1. The forest, by its presence alone, reduces fatal emissions (the sources of air and water pollution and of noise are rare in the forest).

2. The forest regulates the torrents and supplies pure water (it has been known for a long time that it restrains high water, the loose ground of the forest permitting a greater infiltration than a cultivated or trampled-down soil). The infiltrated water feeds the springs and supplies the streams between periods of rain. The water flowing out from forest regions is poor in nutritional substances which slows down the eutrophication of our lakes.

3. The forest filters the air. (The tops have the property of eliminating dust particles from the air; this filtering effect, however, acts less on toxic gases).

4. The forest maintains the biological diversity.

5. The forest is an element of the landscape.

The many tasks of the forest justify the protection and the care given to it, in the future even more than in the past.
Source: 6

#496
Keller, T. "Ueber verkehrsbedingte bleirueckstaende auf der forstlichen vegetation." [Lead residues in sylvan vegetation resulting from traffic]. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, (Germany), 3:118-130 (March 1971).

The assimilation organs of conifers lining highways contain lead which increases in quantity with increasing traffic density. The lead content in needles of conifers can serve as an indicator of traffic-induced air pollution. The normal lead content of one-year-old pine needles is about 2-3 ppm. The lead content of needles increases with their age only to the extent that young needles contain less lead than one-year-old or several-year-old needles. The lead content increases in the course of the first year of exposure until a local dynamic equilibrium was established. The lead content decreases with height above the highway surface, especially in the lower part of the tree crown up to a height of 10-12 m. Laterally, the lead content decreases in woods lining the highway within the first 50 m faster than in open country. Up to 90% of all lead remains on the surface of the needles and can be washed off with an acid and a detergent solution. The small residual lead content in needles indicates that exhaust gases are probably only seldom the cause of lead-induced damage to vegetation. While gas exchange measurements did disclose a depression of carbon dioxide assimilation with increasing lead content in needles, it seems that the inhibition of photosynthesis is due primarily to the soiling of the needle surface and to the toxic action of the other pollutants emitted by the exhaust gas.
Source: 1

#1444
Keller, T. "Ueber die ueberwachung der immissionen von kehrrichtverbrennungsanstalten mit hilfe von nadelanalyses auf chloride." [Monitoring the emissions of municipal garbage incinerators by means of foliar analyses for chlorides]. Mitt. Forst. Bundesvers., 97:271-279 (1972).

The rising percentage of chlorinated polymers in municipal garbage leads to increasing concentrations of hygrogen chloride in the stack gases emitted for municipal garbage incinerators. To assess the potential damage posed to forests located near these incinerators, needles from rural forest trees were analyzed during 5 consecutive winters to obtain data regarding the normal chlorine content of foliage and their fluctuations. The following conclusions were reached: the chlorine contents in fresh foliage are higher than in oven-dried foliage, the Cl contents of the needles decrease from the bottom to the top of the crown; the Cl content of the needles tends to decrease slightly with age; on a given site, different species may have different foliage Cl concentrations; the influence of bedrock on the Cl content of foliage is small under conditions of high precipitation; the Cl concentrations in the foliage of a particular tree differs widely from year to year; and distinct and significant increases in the Cl values are found in foliage obtained from areas near garbage incinerators and along highways.
Source: 1

#1442
Keller, Theodor. "Zur phytotoxizitaet staubfoermiger Fluor-Verbindungen." (On the phytotoxicity of particulate fluorine compounds). Staub, Reinhaltung Luft, 33(10):395-397 (Oct 1973).

The effects of sodium fluoride, calcium fluoride, and cryolite on seedlings of Pinus silvestris, Pseudotsuga menziesii, and Betula verrucosa were studied in laboratory experiments. The fluorine compounds were sprayed on the plants in the form of small particles. Sodium fluoride alone induced visible symptoms of partial or total necrosis of the needles in Pinus silvestris. All dusts caused a statistically significant depression of photosynthesis in birch. Calcium fluoride and cryolite may also exert a phytotoxic action classified as invisible injury. In the tested conifera, the depression of photosynthesis was statistically not significant in the absence of visible symptoms of injury. The reduced toxicity of these dusts in conifera is most probably due to the well-developed cuticula and the resin and wax excretions by the needles. This increased susceptibility of conifera growing around aluminum works may be due to gaseous fluorine compounds. All dusts had an increased toxicity and photosynthesis-depressing effect in air with high relative humidity.
Source: 1

#495
Keller, T. "Translocation of fluoride in woody plants." Fluoride, 7(1):31-35 (Jan. 1974).

Foliage of different species of forest trees was analyzed for its fluoride content. The foliage of plants which had been exposed to fluoride exhalates of an aluminum smelter for one to many years was analyzed after it had been allowed to flush and develop in pure air. All samples of the foliage of trees near the factory had increased fluoride content in dry matter as compared to controls. The foliage near the smelter contained 11-136 ppm F in dry matter, whereas controls contained 3-14 ppm. The level of fluoride in first leaves formed in the spring was higher than that in foliage formed later in the year, a fact indicative of depletion of reserves. New foliage of deciduous trees which had been exposed to fluoride fumes in winter exclusively also contained increased amounts of fluoride, a fact which indicates mobilization of fluoride entering the tree via the bark. These data prove that fluoride is being translocated in woody plants.
Source: 1

#11

Keller, T. "Lead as an indicator of the air-filtering effect of woods." 6 p. No publisher and date.

The air-purifying effect of the forest and all perennial vegetation has great importance for environmental protection. For a long time, it has been known that high-growing vegetation is able to filter significant amounts of dust from the air, while its absorptive effect for gaseous pollutants is evaluated as modest. The toxicity of some gaseous pollutants makes them less absorbable.

Source: 8

#497

Keller, T., and E. Bovay. "Pflanzenschaedigungen durch Schwefeldioxyd Immissionen." (Plant damages due to sulfur dioxide immissions). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, 4:48-56 (1966).

Sulfur dioxide causes damage to plants by disrupting assimilation processes and enzyme systems. Chlorophyll is attacked, and the closing mechanism of the respiratory openings of the leaves is paralyzed. Both crops and nutritive values of farm plants decrease and resistivity and vitality are impaired. Plants can detoxify SO2 by oxidizing it to sulfate. Thus, the different resistivities of certain species and individual plants in different periods of the year can be explained by their different degrees of SO_2 absorption and detoxication, and by their assimilation activity. Increased doses of nitrogen and potassium are useful in agriculture. Coniferous trees, the most sensitive to SO_2 suffer losses in growth rate, resistivity, and vitality as secondary effects. Farm plants show different degrees of resistivity at different stages of development; thus, in cereals, the critical stages are those of trefoil and generative growth. Sugar, starch, and protein reserves are decreased due to disturbed assimilation. Sulfur dioxide damage can be evaluated by symptomatology (coloration and premature leaf drop) and lead analysis. A special nephelometric test has been developed for pine needles. Measurements of assimilation, transpiration, and growth rate, however, both are complicated and time-consuming. In comparative tests, two plants are cultivated under identical conditions, one in an atmosphere without SO_2.

Source: 1

#1443

Keller, T., and H. Schwager. "Der Nachweis unsichtbarer (physiologishcer) Fluor-Immissions-schaedigun gen an Waldbaeumen durch eine einfache kolorimetrische Bestimmung der Peroxidase-Aktivitaet." (The detection of hidden F injury of forest trees by a simple colorimetric determination of peroxidase activity). Text in German, Eur. J. Forest Pathol., 1(1):6-18 (1971).

A simple routine method is described for colorimetrically determining peroxidase activity in foliage of forest trees, including conifers. Peroxidase activity increases with aging of tissues. Fluoride emissions add to this natural tendency, thus leading to premature senescence; the increased fluo-

ride content in assimilation organs is associated with increased peroxidase activity. External dust influences peroxidase activity only after several hours, while peroxidase activity is very little affected by variations in tissue water content. An analysis of potted plants and fluoride emissions indicates that peroxidase activity and the fluoride content of foliage increases with decreasing distance. Increased peroxidase activity may occur without or before symptoms of visible fluoride injury develop.
Source: 1

#208
Keller, T., and R. Zuber. "Ueber die Bleiaufnahme und die Bleiverteilung in jugen Fichten." (Lead uptake and lead distribution in young spruce plants). Forstwiss. Centralblatt, 89(1):20-26 (1970).

Spruce plants potted in sand were fed solutions containing up to 2000 ppm lead as lead nitrate. At the end of the growing season, plant parts were analyzed for lead by atomic absorption spectrophotometry. Measured concentrations were high in roots but low in shoots. Needles that transpired profusely did not differ significantly in Pb content from needles that transpired very little, suggesting the occurrence of only a minute Pb translocation with water transport. Photosynthesis was markedly depressed in plants fed 2000 ppm Pb, but this concentration is unlikely to occur in the field. The planting of spruce hedges along highways is, therefore, recommended. The hedges will protect agricultural crops against lead contamination by exhaust fumes.
Source: 1

#1446
Kelley, J.J. and P.L. Johnson. "Observations of carbon dioxide and plant growth in an Arctic ecosystem." (Final Report). Washington Univ., Seattle, Dept. of Atmospheric Sciences, and Army Cold Regions Research and Engineering Lab., Hanover, N.H., ONR Contract N00014-67-A-0103-0007 Proj. NR 307-242, Rept. 8, 120 pp. (Oct. 1970).

Results are presented of the analyses of atmospheric carbon dioxide and ecological factors at Meade River Camp and at North Meadow Lake (Barrow), Alaska. Reference gas calibrations used in the CO2 program are summarized, and the methods used to obtain the data for CO2 concentrations at both stations are discussed. Variations of CO2 in the air, at ground level, and at 16 m above ground are given for both the Meade River Station and North Meadow Lake. Meteorological observations are presented for the period of observations. The rate of growth percentage of five species of tundra plants is shown, and the correlation between CO2 concentration in the atmosphere and the amount at ground level is given. Data for the amounts of chlorophyll and dry weight production in each of four types of communities are presented. A list of publications resulting from the interpretation of these data is included.
Source: 1

#1429
Kellogg, W. W., R. D. Cadle, E. R. Allen, A. L. Lazrus, and E. A. Martell. "The sulfur cycle." Science, 175(4022):587-596 (February 11, 1972).

An attempt is made to put the man-made contribution of sulfur compounds to the atmosphere (and oceans) into perspective by comparing it with the contribution of the natural sources. Sources, sinks, and lifetimes of sulfur compounds in the atmosphere-ocean system are considered. Rainout and washout, removal of sulfur dioxide by diffusion to soil and vegetation, and the dry removal of sulfate particles are discussed. River transport of sulfur compounds and a model of the sulfur cycle are described. Man is now contributing about one half as much as nature to the total atmospheric burden of sulfur compounds, but by A. D. 2000 he will be contributing about as much, and in the Northern Hemisphere alone he will be more than matching nature. In industrialized regions man is overwhelming natural processes, and the removal processes are slow enough so that the increased concentration is marked for hundreds to thousands of kilometers downwind. The main areas of uncertainty and the ones that demand immediate attention because of their importance to the regional air pollution question are indicated.

Source: 1

#567
Kender, W. J., and F. H. F. C. Spierings. "Effects of sulfur dioxide, ozone, and their interactions on Golden Delicious apple trees. Air pollution injuries." Neth. J. Plant Pathol., 81(4):149-151 (1975).

Comparatively little research has been directed at the identification of symptoms of air pollution injury to fruit trees. This study was conducted to gather more data about the effects of sulfur dioxide, ozone and combinations of the two gases on "Golden Delicious' apple trees.

Symptom development, abscission rate and shoot growth were compared with unexposed trees in the same greenhouse.
Source: 2

#1978
Kerfoot, O. "Mist precipitation on vegetation." Forestry Abstracts, 29(1): 8-20 (January 1968).

Many experiments to determine the relationship between fog and mist precipitation and vegetation have been conducted during the last 80 years. On foggy or misty days, or in zones where advective fog is prevalent, moisture is intercepted by vegetation and precipitation is collected in the form of drip and stemflow, even though no rainfall is measured during the same period on adjacent open ground. This deposition of fog droplets on foliage or on the ground beneath may be beneficial to the plant and to the local water company. The present review is a synthesis of published opinion, often controversial. Interception of rain or drizzle by vegetation has usually implied a loss to the water cycle through vaporization in situ of moisure that would otherwise have reached the ground. The distinction between a 'gain' due to removal of

moisture from a fog-laden air flow, and a 'loss', due to interception and evaporation of meteoric water is clearly defined. No attempt is made, however, to examine the possibility that some of this atmospheric moisture may be directly absorbed and translocated by the intercepting plant, however relevant the process may be to ecosystem dynamics. The formation of dew, although an important process in certain regions, is generally associated with clear atmospheric conditions and lies outside the scope of this review. Sonte (133) and Monteith (95) have discussed in detail the importance of occult precipitation as a source of water.
Source: 5

#498
Kerin, D. "Delimitation of industrial emissions by means of plant analysis." Protectio Vitae, 16(5):201-202 (Oct. 1971).

Vegetation damage in areas surrounded by metallurgical and industrial plants are mainly caused by sulfur dioxide and fluorine compounds. Plants are much more sensitive that humans or animals to SO2. Many plant varieties show signs of damage at a concentration of 0.3 ppm SO2. Fluorine and its compounds are particularly injurious to cherries, grapes, plums, various ornamental plants, and vegetables. The Ontario variety of apples is very susceptible. Visible damage to buildings is also caused by this group of pollutants. For determination of the effect of the above pollutants on vegetation, needle samples were taken in September and October in polluted areas and compared to needle samples from unpolluted regions. First and second year needles were separated. Average samples were taken from 100 grams dried needles. Sulfate, lead, zinc, iron, and manganese were determined. Plants taken from the immediate vicinity of a glass work were heavily contaminated with fluorine. Concentrations of 4.0 to 25 mg F/kg dried basis were measured. The sulfur concentration was between 0.50 to 1.5% (natural concentration is 0.20%). The lead concentration ranged from 24 to 1.136 mg Pb/kg (natural concentration is 3.0 mg Pb/kg dried needles). The zinc content ranged from 136 to 495 mg Zn/kg dried needles; in unpolluted areas it is 28 to 75 mg Zn/kg.
Source: 1

#1447
Kerin, D. "Die Bewertung des Spurengehaltes der Pflanzen auf dem Gebief des Umwelischutzes." (Analysis of the concentration of trace substances in plants in the field of environmental pollution). Proc. Simp. Int. Agrochim Fitonutriz. Oligominerale, Punta Ala, Italy. 283-288 (Oct 2-6, 1972).

Plants and soil samples taken in the vicinity of metallurgical plants were analyzed by spectrophotometry and atomic absorption. The iron concentration is spruce and pine needles from the vicinity of a steel plant ranged 200 to 700 mg per kg dry substance. More than 40% of the examined samples had an iron concentration of 400 mg/kg or higher. The iron concentration in needle samples from a non-industrial area ranged from 65 to 140 mg Fe/kg dry substance. Iron and manganese concentrations of needle samples from the vicinity of a lead plant were considerably higher than from an non-industrial environment. The same is true for sulfur and fluorine. The lead concentration of pine needles from non-industrial area measured 3 mg Pb/kg. In the vicinity of a lead plant concentrations of up to 1100 mg Pb/kg were measured. The lead concentration of hay measured 1700 g Pb/kg, in non-industrial areas the average concentration measured was 5.26 mg/kg. Other examples are discussed concerning zinc.
Source: 1

#1845
Kerin, Danimir. "Waldrauchschaeden der Blei- und Stahlindustrie im Voralpengebiet Jugoslawiens." (Fume damage to forests by the lead and steel industry in the Fore-Alps region of Yugoslavia). Mitt. Forst. Bundesvers., 97:129-139 (1972).

The fume pollution from the Mezica lead works and the Ravine iron works has caused forest damage in the Fore-Alps region, not far from the Austrian border in Carinthia. The pollution affects a total area of over 2000 hectares. The roasting of sulfidic lead ores releases over 10 tons of sulfur dioxide and aerosols containing lead and lead oxide into the air everyday. There are large accumulations of Pb and sulfur in the soil. Over 90% of the pine and silver fir needles investigated exhibited a high S content. Values of up to 0.33% sulfate (86% dry matter) are considered normal from an unpolluted area. The SO4 content of the needle samples from the polluted region was 0.61-1.0% SO4 in 10% of the samples, it was over 1% SO4. The iron content of needle samples from unpolluted areas averages 123 ppm. Over 80% of the samples in the polluted area of the Ravine iron works contained 200-1200 ppm Fe; most of the samples were in the range 200-700 ppm. The iron works also emitted SO2 and manganese. The Pb content of the needle samples from an unpolluted area is 3-6 ppm; from the Mezica Pb works area it was 30-500 ppm Pb, most of the samples were in the range 50-200 ppm. Air sulfur dioxide concentrations were 0.1-0.2 ppm on the average, with short-term peaks of 0.5-1.5 ppm. The average value of the turbidity test from an unpolluted area is 29, while 60% of the needle samples from the polluted area gave turbidity test values of over 75 (severe damage), and 30% of the samples gave 56-75 (medium damage). The chemical values agreed with the visible signs of damage in the conifer forest regions. Sulfur dioxide in the air and zinc in leaves were also measured near a Zn plant.
Source: 1

#339
Kerin, Z. "Verunreinigungen von Gemuese aus Emissionen einer Bleihuette." (Contamination of vegetables by the emissions of a lead refining plant). Qualitas Plant. Mater. Vegetabiles, 15:372-379 (July 10, 1968).

Harvest-ripe samples of vegetables (Cichorium endivia, Cichorium intybus, Brassica oleracea, sauerkraut, Phaseolus vulgaris, parsley leaves, and roots, potatoes, red beets, and carrots) were collected in various distances from a lead-refining plant in the years 1965 and 1966. The vegetable samples were analyzed in washed and unwashed states. The samples were dried and pulverized and mixed with nitric acid. A spectrophotometer was used for the determination. Contaminated unwashed Cichorium endivia contained 19 to 104 ppm Pb (average 57 ppm Pb) while the control plants contained only 1.30 ppm Pb. In the washed state, the lead content ranged from 5.0 to 55.0 ppm in contaminated plants. In washed control plants, the lead concentration was 0.50 ppm. Similar high lead concentrations were found in all other vegetables from the contaminated area. Although a large fraction of the lead can be washed off the plants, a considerable amount still remains on the plants. Tuberous plants had lead concentrations of 10 to 50 times higher than tuberous control plants. This fact is important, because it is a consequence of the high lead contamination of the soil which will last for decades, despite the planned installation of filters. Likewise, restriction of the addition of tetraethyl lead to automobile fuels will not erase the lead contamination of the soil along highways.
Source: 1

#499
Kerr, Eric D. and John L. Weihing. "Effects of ir pollution on vegetation in Nebraska." Nebraska Univ., Lincoln, Extension Service; Dept. of Agriculture, Washington, D.C.; and Nebr. Pollut. Probl., Lincoln, Nebr., p. F-1 - F-10 (April 22, 1971).

The effects of phytotoxic air pollutants on plants in the United States, primarily Nebraska, are reviewed. Plant damage caused by exposure to sulfur dioxide, fluorides, ozone, peroxyacetyl nitrate, ethylene, and nitrogen dioxide include acute and chronic leaf injury, chlorosis, lesions, stipples, flecks, necroses, and abcissions. Toxic doses and plant sensitivity were correlated, and factors affecting plant sensitivity are discussed The relationship of air pollutants to infectious plant diseases was investigated. Specific damage to plant life in Nebraska and major sources of the phytotoxicants were designated.
Source: 1

#1449
Kershaw, K. A. "Lichens." Endeavor, 22:65-69 (1963).

The extreme susceptibility of lichens to air pollution is emphasized in a discussion of the distribution and ecology of the two symbionts. The susceptibility is possible due to the indiscriminate and rapid absorption of solutes over the surface of the thallus. Lichens are virtually absent from towns and industrial area. In an investigation in Kvarntrop, Sweden, the distribution of lichens corresponded markedly with the levels of air pollution, mainly by sulfur dioxide and secondly to the low humidity of the area. There are a few lichens that are tolerant of pollution and occur abundantly in industrial and sururban areas. Lecanora conizaeoides and Stereocaulton pileatum are prevalent in large cities of Great Britain and are early colonizers of trees and brickwork. The apparent preference of lichens for asbestos roofing in polluted areas is related to the high water absorbing power of the substratum and the high base content, with the consequent power of neutralizing acidic atmospheric pollutants. The flora growing on an asbestos tiled roof eight miles from London was examined and revealed four species: S. muralis, L. dispersa, R. demissa and C. vitellina. The density of the S. muralis was approximately 1/sq m with diameters up to 6 cm. The density of the other species was extremely high up to 368 apothecia/sq cm for L. dispersa. The figures suggest that the high water absorbing properties and basicity of the asbestos are the factors responsible for the prolific lichen growth.
Source: 1

#1272
Khan, M. A. Q., W. F. Coello, and Z. A. Saleem. "Lead content of soils along Chicago's Eisenhower and Loop-Terminal Expressways." Arch. Env. Contam. Toxico., 1(3):209-223 (October 1973).

The lead content of soils along Chicago's two expressways, the Chicago Loop-Terminal Expressway and the Eisenhower Expressway, was determined in various seasons of the year and at various distances from the roadway. The concentration of lead in soils along the Chicago Loop-Terminal Expressway and adjoining city streets show positive correlation (correlation coefficient equals 0.988) with the average traffic volume near the sampling sites during the same season. The levels of Pb in soils along the Eisenhower Expressway at the same site vary with the season, the Pb levels attain peak values during summer. The seasonal variation in the Pb levels is the least during fall and winter, increases during spring, and attains peak values during summer. The seasonal variation in the Pb levels is similar to the seasonal variation in average monthly traffic volume on the expressway. The soil contains as much as 7600 ppm of Pb (micrograms/g of dried soil) up to 45 ft and 900 ppm up to 150 ft from the Eisenhower Expressway.
Source: 1

#1271
Khesina, A.Y., N.P. Shcherbak, L.M. Shabad, and I.S. Vostrov. "Benzypyrene breakdown by the soil microflora." (Russian). Byul, Eksperim. Biol. i Med., 68(10):1139-1141 (Oct. 1969).

Measurements of the benzypyrene content of selected soils were made before and after exposures of one, two, and three months. The results show that soil microflora are able to destroy up to 70% of the benzpyrene contained in soil, provided the soil is moist. This phenomenon is evidently due to the metabolic activity of the microorganisms and is most marked in soil contaminated with polycyclic hydrocarbons from industrial waste.
Source: 1

#528
Kira, T., M. Andō, and H. Sato. "Kōgai to Rikujyō Shyokubutsu." (Environmental disruption and terrestrial plants). Lecture given at the Symposium of the 18th meeting of the Environmental Problems Professional Committee (March 1971) (Reprinted from Japanese Journal of Ecology, 23(2):65-73 (April 1973).

There is a very close connection between environmental pollution and terrestrial plants. The paper summarizes the main aspects of the relationship. The presentation is limited to discussing the direction of completed experimentation and research, plus possibilities for future research. (1) Environmental problems and plant life on a global scale (2) Plant life and the results of environmental improvement on a local scale (3) The effects of environmental pollution on plant life in the city of Osaka (4) Using plants as an indicator of pollution.

Article 1 - Earth's environment and plant life
Diagram 1 - Carbon and the Life Cycle of Earth
Chart 1 - Estimate of amount of primary production of Earth

Article 2 - Local conditions and plant life
A) Absorbtion to carbon and release of oxygen
B) Absorbtion and adhesion of atmospheric pollutants
Chart 2 - Apportionment of solar energy on plant clusters
2nd column: poor field of wheat
3rd column: good field of corn
1st row: total radiation
2nd row: amount absorbed by soil
3rd row: amount used in evaporation of water
4th row: amount radiated as heat (to air, to earth)
5th row: amount used during photosynthesis
C) Results of temperature control

Article 3 - Damage to plant life in cities
Chart 3 - Comparison of physiological functions of leaves on trees in various parks in Osaka
A) Area of light pollution
B) Area of average pollution
C) Area of heavy pollution
Diagram 2 - Distribution of degree of branch development of Himalyian Pine in parks in Osaka (Top: setting the amount of growth in a large park outside the city equal to 100 and comparing 1965 investigation and, the distribution of concentrations of SO_2 gas in Osaka city in 1968. Bottom: average yearly amount of $SO_3/100\ cm^2$ day in milligrams according to official city sources (1969)).
Source: 2

#1450
Kirschbaum, A. and R. Klee. "Flechtenexplantate und natuerliche Flechtenvorkommen." (Lichen explants and natural occurrence of lichens). Untermain, 4th, Frankfurt am Main (West Germany), Lufthyg.-Meteorol. Modelluntersuch Reg. 64-66 (Nov. 4-5, 1971).

Lichenologic studies with lichen explants and with naturally occurring lichens, being conducted in the Lower Main region in West Germany within the framework of an air hygienic and meteorologic model study of that region, are described. Parmelia physodes explants from oak trees growing in nonpolluted areas were exposed in polluted areas, such as in an industrial area, an airport, a petroleum refinery, and near a large chemical plant. The degree of air pollution in the exposure site was evaluated by the degree of the lichen damage in seven grades. The large-scale average distribution of air pollution in the survey area was studied by surveying the natural occurrence of lichen species on 10 apple trees in area units of 6.25 sq km each. The lichen explant and lichen survey methods compared by the study of naturally occurring lichen at a nearby of the exposure site of lichen plants.
Source: 1

#1451

Kirschbaum,U., R. Klee, and L. Steubing. "Air quality measurements on account of immission influences on lichens - lichens as bio-indicators." In: Air Hygienic Meteorological Model Studies of the Lower Main Region, Report 5. Regional Planning Assoc., Lower Main Region, Frankfurt am Main (West Germany), p. 116-127 (June 1974).

At 150 observation stations the bark of apple trees was examined for lichen growth. At each station 10 apple trees were thus examined. The limitation to one type of tree was to ensure that essential factors for lichen growth - with exceptance of the emission factor - would be as constant as possible. From the lichen growth it was possible to calculate the air purity index according to LeBlanc and De Sloover. A summary of the lichen indices of similar value results in zones as shown on a map. There is a clear relation to the main pollution source (Frankfurt) and to the prevailing wind direction: as the distance from the city grows the living conditions for lichens improve gradually. However, on the leeside of the densely populated area lichen growth conditions improve later than in other directions. Of the examined lichens, Lecanora varia is not suitable as a bio-indicator because its toxic tolerance is too high; Evernia prunastri is already so scarce that it can no longer be used as an indicator close to the city. The most suitable species was Hypogymnia physodes. It was therefore used for exposure tests in various pollution areas. A significant correlation was found between the results of the exposure tests and the results of observations of the lichen growth on trees. Lichen explants can therefore be used for gaining information on the state of air pollution within short periods of time. A connection between lichen growth and pollutant concentration could also be observed. A table of sulfur dioxide tolerance of various lichen species is given.
Source: 1

#500

Kirste, H. "Die Auswirkungen von Luftverunreinigungen auf den Landbau." (Effects of air pollution on agriculture). Text in German. Landwirt. Forsch. Sonderh., 17:1-12 (1963).

The land in the industrial zone of West Germany known as the Ruhr is 57.4% tillable, which is only slightly below the national average for West Germany. Although in itself suitable for agriculture, it is surrounded by certain influences, notably pollution of the atmosphere close to the soil, which render agriculture a difficult task. About 85% of the power supply of West Germany is derived from raw materials whose combustion creates air pollution problems. Some industrial comlexes give off gases and vapors whose combined weight is 10 times that of the dust and fly ash emitted. The term emission, used in a number of European Countries, can be defined as the occurrence of solid, liquid, and gaseous air polluting substances whose effects are principally felt near the ground. The detrimental effects of dust on the marketability of eash crops and the value of crops raised for livestock feed has long been recognized. Only more recently has the relationship between pollution and susceptibility to plant diseases been recognized. In assessing the effect of polluting gases on plants and trees, the determination of physiologically important substances, such as pheophytin, carotin, and the amino acids is just as important as detailed studies with the microscope. In diagnosing the causes of pollution-induced plant diseases, an older technique, that of Sorauer, has been resurrected. A practical illustration is given of the application of this method.
Source: 1

#501

Kisser J. "Forstliche Rauchschaeden aus der Sicht des Biologen." (Smoke damages of forest from the biologic standpoint). Text in German. (Presented at the Symposium on Smoke Damage to Forest in Austria, Vienna, Austria, Nov. 9-11 1965.) Mitt. Forst. Bundesvers., 73:7-48 (1966).

The biological aspects of smoke damage are reviewed with special regard to forests. Due to long exposures, smoke is more harmful to forests than to farm plants. Forest damage is termed as injuries and disfunctions causing economic losses. Invisible physiological damage due to protoplasm lesions is counteracted by the regenerative effect of certain enzyme systems. Insoluble solid emissions reduce both light and assimilation, while soluble particles may penetrate the plant or soil, causing changes in the vegetation. Damage caused by soot and photochemical smog is detailed. Sulfur dioxide and hydrofluoric acid are two basic gaseous pollutants damaging forests. The importance of the damage is primarily determined by concentration and duration of exposure, with emphasis on concentration, in high concentrations, the substances are dissolved in the mesophyll cell wall fluid, causing point-like necrosis. Low concentration lead to necrosis on the ends and edges of leaves and needles. The basal and end parts of the needles show different osmotic pressures. Due to disturbances in the water supply, the necrosis starts from the top part of the tree. Intervals between intermittent exposures lessen the damage. Damage is also influenced by climatic factors. The assimilation is dependent on light intensity and duration. Transpiration and consequently sensitivity to SO_2 are dependent on relative humidity. A sharp increase in sensitivity can be observed from 60 to 90% relative humidity. There is no direct connection between transpiration rate and assimilation performance. High transpiration coefficients are characteristic of dry climates. There is no relation between transpiration and sensitivity, while any factor affecting the cuticular openings influences the extent of the damage. Resistance to smoke cannot be improved in forests by means of fertilizers. Different resistances of various tree species and individual trees as well as problems of breeding smoke-resistant species are discussed.
Source: 1

#1453

Kisser, J. "Probleme der Zuechtung rauchresistenter Holzarten." [Problems of the cultivation of smoke-resistant tree varieties]. Proc. Congr. Intern. Union Forest Research Organizations (Munich), 5(24):510-517 (1967).

In order to prevent further spread of damage to forests from industrial air pollution, new legislation will have to limit the emission of pollutants. On the part of the silvicultural sector, two approaches are available to counteract the noxious effects of pollution. One is the observation that a judicious supply of minerals to trees increases their resistance to emissions, but more experimental work will be required before this measure can be introduced on a large scale. The second possibility of fighting pollution rests on the recognition that differences in resistance to pollution exist in individual trees of the same species. This has been confirmed both

from observations in pollution-damaged timber stands and by experimental work. Whether the difference in resistance is anatomical or physiological is not yet known, although the latter seems the more probable. It should be possible to obtain by selection and cultivation conifers able to prosper in conditions under which present-day conifer populations die. The one remaining problem in this approach is the question of propagation. Propagation of resistant species by seeds is not possible; thus the propagation will have to be accomplished either by grafting, or better still, by rooting of cuttings from resistant parent trees.
Source: 1

#1452

Kisser, J. "Phsiologische probleme der Einwirkung von Luftverunreinigungen auf die Vegetation." (The physiologic effect of pollution on vegetation). Text in German. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowecj Konf., Wplw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p. 27-43 (Sept. 9-14, 1968).

The observations that individual plants in a monoculture react differently to air pollution, that gladioli strains differ in their resistance to pollutants, and that resistance of a plant to hydrofluoric acid does not coincide with its resistance to sulfur dioxide lead to the conclusion that generally there are no pollution resistant plants or strains but only increased resistance to a certain chemical compound. The major part of damage to vegetation can be attributed to gaseous components of smoke emissions which penetrate into leaf tissues by gas diffusion. The degree of damage to leaf cells depends basically on the quantity of gas that penetrates into the leaf tissues and on peak concentrations, if the leaf pores are open during the emission period. Exposure of plants to hydrochloric acid caused a depression of the water balance while exposure to SO_2 caused an initial rise, indicating that the effect on the pore opening mechanism can differ from gas to gas. Higher osmotic pressures and greater diffusion in peripheral regions and leaf tips were found in all plants examined, where leaf damage is initially manifested. In some cases the distribution of leaf damage is also determined by leaf veins.
Source: 1

#1454

Kitamura, F., K. Takahashi, and Y. Kawajiri. Taiki osen ni yoru zoen jumoku no yoshoku henka ni kansuru kenkyu. (Studies on the leaf-color changes of garden trees and shrubs by air pollution). Text in Japanese. Tokoyo Daigaku Nogakubu Engei Jikkensho Kenkyu Hokoku. (Bull. Demigaroa Arbor. Fac. Agric. Univ. Tokyo), 6:16-12 (October 1973).

The leaves of various species of garden trees and shrubs planted in both heavily polluted and lightly polluted areas were observed by naked eye and with a color meter to investigate leaf-color changes caused by air pollution. Color meter observations showed that lightness of color tended to diminish and depth of green and yellow color tended to decrease in places where air pollution was great. Leaf-color changes caused by air pollution was greatest in Euonymus japonicus and Ligustrum lucidum, followed by Ligustrum japonicum and Cinnamonum amphora. Color changes were not very clear in other species. No correlation was recognized between durability against pollution and degree of leaf-color change.
Source: 1

#1455
Klee, R. and A. Warns. "Aussagewert von Flechtenexplantaten fuer eine Immissionbelastung." [Evidence reliability of lichen explants for an incidence of immission]. Ber. Deut. Bot. Ges., 84(9):515-522 (1971).

The reliability of lichen as biological indicators of emissions was investigated. The reaction of Parmelia physodes explants to certain emissions under varying climatic conditions was tested. The quality classification of visible damage served as the criterion for lichen damage. Lichen explants were exposed in two series -- fall-winter and spring-summer at various times and in various weather conditions in Frankfurt. Explant boards were photographed at set time intervals to measure plant damage from the weather and SO2 emissions. The damage of Parmelia physodes explants was parallel to the exposure to sulfur dioxide. Lichens were not damaged in the summer, implying that climatic causes are of lesser importance.
Source: 1

#1270
Klein, D. H. "Mercury and other metals in urban soils." Environ. Sci. Tech., 6(6):560-562 (June 1972).

A series of 264 surface soil samples, selected from a 300 sq. mile region which includes industrial, agricultural, and residential areas, was analyzed for mercury, silver, calcium, cadmium, cobalt, chromium, copper, iron, nickel, lead, and zinc. All these metals were more concentrated in industrial areas than in residential and agricultural areas, and all except lead were more concentrated around the airport. An asphalt plant appeared to act as a point of mercury discharge. For all the metals except calcium and lead, agricultural soils were slightly richer than residential soils.
Source: 1

#1431
Klein, D. H. "Mercury in the environment." Hope College, Holland, Michigan, Chemistry Dept., Environmental Protection Agency Proj. 16040 FRL, Program Element 1BA027, Rept. EPA-660/2-73-008, 28 p. (December 1973).

Soil, sediment. and water analyses for mercury were obtained from the characteristically low-metals environment of western Michigan and compared with levels of other metals to study distribution patterns resulting from the atmospheric discharge of mercury. Industrial point sources identified included: an asphalt plant, airports, and a coal-burning power plant. Assuming a mean mercury content of 0.3 ppm for the coal used, about 4 tons of mercury were expected to be present in nearby soil compared to the 0.05 tons actually found. This indicated that mercury discharged from the burning of coal deposits by a mechanism other than the short-term dry fallout associated with less volatile metals, presumably entering a different atmospheric circulation pattern and being dispersed over a much wilder area. Mercury was associated primarily with suspended solids in local lakes and rivers. Concentrations of mercury, as well as other metals, in sediments correlated strongly with the organic content and the fraction of fine particulates. Sewage treatment plants also represented a large source of mercury discharge (about 1000 lb per million population): this mercury was associated primarily with the suspended solids.
Source: 1

#1430
Klein, D. H. "Fluxes, residence times, and sources of some elements to Lake Michigan." Water, Air, Soil Pollut., 4(1):3-8 (March 1975).

The influx of 28 elements to Lake Michigan is calculated from literature data on sedimentation rates and concentrations in sediments and water. Lake Michigan residence times are roughly 10,000 times lower than oceanic residence times. A mass balance calculated for 24 elements, with soil and aerosol deposition as the only sources, reveals fourfold excesses of copper, mercury, antimony, selenium, and vanadium. Order of magnitude deficits are calculated for calcium, magnesium, sodium, and chlorine. The mass balances account to within 50% for the observed inputs of silver, aluminum, arsenic, bromine, cobalt, chromium, iron, potassium, lanthanum, manganese, sulfur, silicon, scandium, thorium, and zinc. Except for Al, Co, La, Si, and Th, deposition from aerosol accounts for at least one-fifth of the total input.
Source: 1

#1456
Klein, D.H. and P. Russell. "Heavy metals: Fallout around a power plant." Environ. Sci. Technol., 7(4):357-358 (April 1973).

The degree of fallout of heavy metals around a coal-fired power plant was measured with respect to soil and plant material enrichment. Samples of soil, grasses, leaves, and biota were analyzed for contents of iron, titanium, zinc, cobalt, chromium, copper, nickel, cadmium, silver, and mercury, and the data were correlated with wind patterns. The soils were enriched with Cd, Co, Cr, Cu, Fe, Hg, Ni, Ti, and Zn and the plant materials were enriched in Cd, Fe, Ni, and Zn. Soil enrichments correlated with wind patterns and with the metal content of the coal except for Hg, which was only slightly enriched.
Source: 1

#502
Kleinman, A. "Investigation of lead residues on growing fruits and vegetables." Pesticides Monitoring J., 1(4):8-10 (March 1968).

One hundred and thirty-two samples of a variety of mature fruit and vegetable crops grown near heavily traveled highways were collected and analyzed for lead. Samples, ranging from four to 15 lb. were examined without washing or peeling. The smaller samples were ground and mixed in entirety; the larger ones were reduced to about 1 kg and then composited, ground, and mixed. Appropriate aliquots were analyzed by the official A.O.A.C. dithizone spectrophotometric procedure. Reported recoveries of added lead in recovery experiments ranged from 70 to 100%. Lead residues were compared with distance from the highway, traffic load, and the period of exposure to these conditions. The data suggest that a difference exists between crops growing adjacent to traffic and crops growing at further distances.
Source: 1

#1457

Klemm, W. "Contribution concerning the relationship between water balance and fune damage to pines." Biol. Zentral, 85(6) :781-783. 4p. (1966). Translated from German. McGregor and Werner, Inc., Washington, D.C., Mundas Systems.

The relationship between water balance and fume damage to pines is reviewed. Various studies have indicated that, under circumstances which favor carbon dioxide assimilation (high light intensity, good water supply), the sensitivity of plants to sulfur dioxide, i. e., smog, increases. Tests were undertaken to examine the water supply of damaged trees by a screening method with which the water supply of the tree was measured in relative units by determining gamma ray reduction. The experimental method is described, and water content and radiation decrease charts are presented. Tests indicated that water deficits in damaged trees were greater than in healthy trees.
Source: 1

#1977

Klepper, Betty and D.K. Craig. "Deposition of airborne particulates onto plant leaves." J. Environmental Quality, 4(4):495-499 (1975).

In order to assess potential environmental hazards from foliar absorption of airborne pollutants released in stack effluents from industrial plants, it is necessary to measure deposition characteristics onto plant foliage. This paper describes an exposure chamber which permits highly toxic materials to be delivered to plant leaves under reproducible conditions of wind speed and aerosol concentration. An aerosol of a gold colloid labelled with ^{198}Au and having an activity median aerodynamic diameter (AMAD) of about 0.8 μm was used in experiments with bean leaves (Phaseolus vulgaris) L. var.'Tendergreen') and with inert surfaces. Measurements were made of leaf area, wind speed, and aerosol concentration and particle size distribution. Leaves oriented toward and away from winds of 0.42 cm/second showed similar deposition rates for particles with an AMAD of about 0.8 μm. Deposition velocities for leaves were similar to deposition velocities measured for upward facing inert surfaces which were an order of magnitude greater than downward facing inert surfaces for the aerosols and wind velociites used in these experiments.
Source: 5

#1269

Kloke, A. "Cadmium in the environment." In: Report on Third Technical Meeting on Occurrence and Significance of Chemicals in the Environment, Berlin (West). 7 p. (Jan. 1972).

The cadmium content of the soil is being increased from a variety of different sources, and this is followed by a corresponding increase in the cadmium content of plants. In general, zinc and cadmium contaminate the water where these chemicals are used in technical processes. The atmosphere is polluted with these metals following the burning of paper, synthetic materials, coal, domestic heating, and diesel oil which has led to the enrichment of soils and plants along the sides of motorways. Following the application of phosphate fertilizers, cadmium can be deposited in small amounts in the soil. Although local applications of pesticides containing cadmium lead to very low levels of environmental contamination, the Federal Republic of Germany has banned the use of pesticides containing this metal. In that cadmium is as poisonous as mercury, the maximum safe air concentration for cadmium in work places is 0.1 mg/cu m air. More attention should be paid to this element.
Source: 1

#1458
Kloke, A. "Schwermetalle in Nahrungs- und Futterpflanzen." (Heavy metals in food and fodder plants). Deut. Lebensm. Rundsch., 69(1):45-49 (1973).

The concentrations of lead, cadmium, and mercury in food and plants are presently of major concern. The high concentration of lead in soild and plants is due to two sources, automobile exhausts and the lead industry. The normal lead concentration of plants is between 2 and 10 ppm. In the vicinity of highways and steets this value is two to three times higher. If it is assumed that the lead emission, by automobiles spreads to 50/m on both sides of the street or highway, then the Federal Republic of Germany has 750,000 hectare with lead polluted plants (3% of the agriculturally usable area). The sources for the cadmium pollution are also automobile exhausts, the industry, and fuel oil. Lubricants, diesel oil, and fuel oils contain between 0.07 and 0.53 ppm cadmium. In the vicinity of streets the Cd concentration in plants rose from 0.22 ppm at 32 m to 1.45 ppm at 8 m from the highway. Canadian studies have revealed that at 15 m from a CD-emitting plant, 44 ppm Cd concentrations occurred in vegetation and at 90 m 0.45 ppm. The normal atmopsheric concentration of mercury is 0.01 micrograms/cu m. In the air near mercury-emitting industries, concentrations up to 20,000 micrograms/cu m were measured.
Source: 1

#568
Kloke, A. "Beeintrachtigung der Qualitat von Nahrungs- und Putterpflanzen durch Umweltchemikalien, insbesondere durch Schwermetal le." (Influence of environmental chemicals, especially of heavy metals, on the quality of food and forage plants). Qual. Plant Foods Human Nutr, 24(1/2):137-157 (December 20, 1974).

There are many environmental chemicals; the author only discusses those which are transported from the emittent to the plant by air. The range of effective amounts of this air load comes to about 3 km for emittents and industrial and housing areas and to about 50 m for roads and highways. From the basis of these numbers it is estimated that only 7% of the agricultural and horticultural profitable area of the Federal Republic of Germany are situated in the range of the influence of air pollution and accordingly about 93% of the plant production of the Federal Republic of Germany are not much influenced in their quality. Within industrial and housing areas and their 3 km-belt mainly fresh vegetables are cultivated; these products may be polluted. Extended consumption of food plants from this area only may be dangerous for health if in the actual immission type there are substances in relatively high concentrations which already in low amounts are injuring to man. In many immission types SO_2 is a great factor of damage for plants because already 0.2-0.4 mg SO_2/m^3 air may cause damages. Consecutive damages e.g. deterioration of quality, which are also important for man apart from direct scorching by SO_2 or HF are as yet unknown. Fluor is much more dangerous in this respect because fluor damages to plants have the appearance of damages by dryness and may only be detected by fluor analysis. Concerning the heavy metals more attention has to be paid to the influence of cadmium to the human health. Unfortunately, there is still little known about the distribution of this element in food plants. Less important than

mercury is the recently much discussed lead. Nevertheless, it is required not to enrich plants and soils with substances which are disadvantageous for the human health - even if their effects do not appear at once but after accumulation or in cooperation. It cannot be discussed about the high quality of a plant as long as it contains any substance in an amount dangerous for man. Negative quality indices (poisoning) are not counterbalanced by positive ones.
Source: 2

#1848
Kloke, Adolf. "Blei-Zink-Cadmium, Anreicherung i Boeden und Pflanzen." (Lead, zinc, cadmium, enrichment in soils and plants). Staub, Reinhaltung Luft 34(1):18-21 (Jan. 1974).

The normal lead concentration of the lithosphere was 16 ppm as earlier literature reports, that of the soil between 2 and 20 ppm and that of plants less than 10 ppm. Along traffic routes the lead concentration generally doubles or triples to 20 to 30 ppm, at the most it rises by five to tenfold. Under unfavorable conditions values from 100 ppm up to 1000 ppm were measured in the dry mass of plants. About 30 to 70% of this quantity can be washed off. In the vicinity of lead plants concentrations of 400 to 1200 ppm were measured. The normal zinc concentration of mineral soil amounts to 10 to 300 ppm and healthy plants contain 20 to 100 ppm zinc. In the vicinity of a zinc plant the Zn concentration of the soil rose to between 900 and 1500 ppm. In the vicinity of lead/zinc plants in Wales the zinc concentration in soils was found to be 100 to 1300 ppm and of plants 20 to 360 ppm. In Pennines Zn concentrations of 800 to 1300 ppm were recorded in soil and of 400 to 1400 ppm in lichen. In the vicinity of traffic routes the Zn concentration of soil and plants also rises. For example 192 ppm Zn were measured in the soil at 8 m distance from a street and 41.2 ppm in grass. The Cd concentration of the lithosphere is 0.18 ppm of non-polluted soil 0.01 to 0.2 ppm, of plants 0.2 to 0.5 to 3 ppm in the dry substance. Cadmium is emitted by industries, by the combustion of fuel oil and coal and by diesel oil-operated automobiles. At 8 m distance from a traffic route in the U.S. 1.45 ppm Cd were measured in the soil. Canadian investigations show that the Cd concentration at 15 m distance from an industrial plant was 44 ppm and higher by a factor 100 than at 90 m distance where 0.45 ppm were measured.
Source: 1

#47
Kloke, A. and H.O. Leh. "Verunreinigungen von Kulturpflanzen mit Blei aus Kraftfahrzeugabgasen." (Pollution of cultivated plants with lead from auto exhaust). Air Pollution Proc. First European Congr., Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 259-268 (1968).

Plant samples from areas adjacent to and remote from dense traffic were analyzed for lead. The lead content of the green parts of plants increased with increasing closeness to well-travelled highways and streets. Even in the vicinity of highways, no increase was noted in lead concentrations in below-ground and inner portions of plants. The lead content of feed plants growing along roads was far in excess of the suggested tolerable concentration of 10 ppm. For the protection of humans and cattle, cultivation of food and forage plants along roadways should be abandoned or the use of tetraethyl lead in fuel prohibited.
Source: 1

#7

Kloke, Adolf and Klaus Riebartsch. "Verunreinigung von Kulturpflanzen mit Blei aus Kraftfahrzeugabgasen." (Contamination of cultured plants by lead from automobile exhausts). Kurze Originalmitteilungen, 51(15):367-368 (1964).

Pollution of the air and of the vegetation by lead is on the increase, caused almost exclusively by automotive traffic. According to the German DIN-norms, gasoline must not contain more than 0.06% tetraethyl lead, and preferably not more than 0.05%. It is estimated (basis 1963) that in the U.S.S. 600 tons of lead/day enter the atmosphere with exhausts. Tests made in the U.S.A. in the vicinity of highways have shown lead contents of up to 300 micrograms, compared to a normal value of five to ten micrograms/g of dry grass substance. If such grass with high lead content is used as fodder, lead poisoning occurs with the cattle, and considerable quantities of lead may then be contained in the milk. Tests made in Berlin in 1963 with grass samples from locations near highways with heavy traffic showed about 50 micrograms of lead/g of dry substance on the grass blades, and similar maximum values in the roots. In the case of the blades, most of the lead could be easily washed off, which shows that very little absorption took place. The roots also contained up to about 50 micrograms of lead/g of dry substance. The lead was apparently absorbed via the soil into the interior of the root. This phenomenon has been observed with plants in general. It seems that very little of the lead absorbed in the roots of plants is transferred to the leaves.
Source: 1

#1223

Knabe, W. "Rauchschadensforschung in Nordamerika - Neue Erkenntnisse und Folgerungen fuer deutsche Verhaeltnisse." (Research on smoke damage in North America - New results and their application for German circumstances). Forstarchiv, 37(5):109-119 (May 1966).

1. Increase of smoke damages from SO_2 and F compounds.
2. Emissions resulting in well known tree diseases.
3. Other research.
4. Changing energy sources and their effect on vegetation.
5. Laws against pollution.
6. Increasing energy demands in America as opposed to Germany.
7. Application for German circumstances.

Source: 6

#1459

Knabe, W. "Experimentelle Pruefung der Fluoranreicherung in Nadeln und Blaettern von Pflanzen in Abhaengigkeit von deren Expositionshoehe ueber Grund." (Experimental testing of fluorine accumulation in needles and leaves of plants in relation to their exposure height above ground). Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p. 101-116 (Sept 9-14, 1968).

At a distance of 4.6 km from an aluminum plant emitting 30 kg F/h (80% in gaseous, 20% in dust form), fluorine emission and accumulation were measured in potted plants, including pine, spruce and poplar saplings, lupines, grasses and cereals placed 0, 4.3, 8.3, and 12.3 m above ground. The differences in fluorine content determined by the Duncan test between various levels were found to be significant in some instances with the fluorine levels increasing in all instances from the ground level upward. The increase was largest from the zero to the 4.3 m level. A steady increase in fluorine content over the entire height was found only in two-year old pine needles; in the other plants the fluorine accumulation curve flattened out with increasing height. If the fluorine content at ground level is taken to be 100%, then following a 20-day exposure at the 12.3 m above-ground level grass reached a maximum of 178%, lupines 173%, mustard 194%, barley 205% and pine needles after a 116-day exposure between 271 and 360% depending on clone and age of needles. The absolute fluorine content difference between the lowest and the highest level was 4.4 mg F/100 g dry matter in lupines and 31.8 mg F/100 g dry matter in pine needles. Differences in wind velocity at the various levels may account for the differences in fluorine levels.
Source: 1

#1224
Knabe, W. "Kiefernwaldverbreitung und Schwefeldioxid - Immissionem im Ruhrgebiet." (Pine stands and sulfur dioxide emissions in the Ruhr Valley). Staub-Reinhaltung der Luft, 30(1):32-35 (1970).

Maximum SO_2 concentrations which could be tolerated by fairly old pine stands were determined on the basis of the data supplied by the 3rd measuring programme in North-Rhine-Westphalia. These maximum concentrations are described by the following values: an arithmetic mean of the year of 0.20, an arithmetic mean of the growing season of 0.18, and I_1 value ($\bar{x} + \Delta \bar{x}$) of 0.24 and an I_2-value ($\bar{x} + \Delta \bar{x}$) of 0.75 mg $SO_2 \bar{m}^3$. It appears that in the case of higher SO_2 concentrations spruce and pine cannot be cultivated, unless some selections are available with high tolerance to air pollution. The air quality standards of $I_1 = 0.40$ and $I_2 = 0.75$ mg SO_2 $\bar{m}^3$ are insufficient for conserving healthy stands of these species which are of the greatest economic importance in German forestry.
Source: 6

#1461
Knabe, W. "Natuerliche abnahme des aus immissionen aufgenommenen fluors in fichtennadeln." [Natural decrease of pine needle fluorine from atmospheric immissions]. Staub-Reinhaltung Luft, 30(9):384-385 (Sept. 1970).

Analyses of fluorine content of atmospheric origin in pine needles performed immediately following exposure and after a 5 months recovery period during which the pine stands were not exposed to fluorine emission disclosed a natural decrease of the fluorine content to only 10 to 17% of the original accumulation. The causes may be leaching out through precipitation, evaporation of volatile fluorine compounds from the needles, transport into other parts of the tree and loss of fluorine to the soil through roots. Experiments with tomatoes and beans speak for the first assumption as the principal cause of the fluorine decrease. The filtering capacity of pine stands for fluorine is greater than was assumed because the results of fluorine analysis represent only part of the absorbed F. It follows that plant fluorine analyses must not be evaluated statically but that they must be interpreted in the context of the dynamics of fluorine intake and outgo.
Source: 1

#1178

Knabe, W. "Natural loss of fluorine from needles of Norway Spruce (Picea Abies Karat)." Reprint from Staub, English Edition, 30(9):29-32 (September 1970).

The fact that pollution-caused fluorine enrichment in spruce needles decreases during reduced or absent fluorine pollution is of considerable importance.

1. Even during nongrowth periods, the results of a plant analysis for fluorine (at least for spruce) depend to a degree much more considerable than so far assumed on the time interval between the taking of the sample and the last fluorine pollution and on the climatic conditions between these two periods.

2. The filtering capacity of spruce forests for fluorine pollutions is much higher than hitherto assumed, since the fluorine amount retained by the needles is only a part of the fluorine amount taken up from the air.

3. The results of long-term fumigation experiments with fluorine during which natural precipitations could not affect the plants, must be interpreted with caution as long as we do not know the fluorine release mechanism during the recovery period. This restriction does not apply to the same extent when testing harmful peak concentrations.

4. The fluorine levels of plants in pollution area are also dependent on the recovery periods. This complicates calculation of absolute values for past fluorine pollutions from the amounts found in biological indicators; on the other hand, it might increase the significance of these indicators as a reference for the F-enrichment of other plants and the damage caused (comp./12,13/).

5. Fluorine containing plant samples must be washed gently and for a very short time only.

But the real significance of these new findings is that we must abandon the view which interprets the analysis of fluorine in plant samples either statically or as a dynamical process taking place in direction of enrichment only. In fact, we have an interplay of fluorine uptake and fluorine release of the leaf organs.

Moreover, our experiments of 1967 to 1968 confirm the observations of an increased fluorine uptake with increasing height of exposure, provided identical cultivation conditions are ensures, especially a sufficient water supply.
Source: 6

#66

Knabe, W. "Agriculture and forest measures to reduce damage from immission." Landwirdschaft Forschung Sonderh., 26(1):41-54 (1971).

The degree of air pollution which has been reached today in Germany requires new efforts by industries to diminish their emissions, as well as attempts by agriculture and forestry to decrease pollution damage to plants by preventive or "passive" measures. To be sure, the possibilities for adjusting

to given air pollutants by appropriate measures are limited from the plant standpoint, and this often entails economic losses for the owner. They are reasonable only where general protective guaranties by the state of the extent of the area exclude extreme pollutant concentrations which would be fatal for all cultured plants at the site of cultivation. The "smoke clearings" around refineries of the 19th century cannot be regarded as control of soil cultivation, but only as the result of a complete lack of environmental protection by the industry.
Source: 8, 6

#1860
Knabe, Wilhelm. "Air pollution and forestry: Effect upon forestry research." State Institute for Immission Control & Soil Conservation, Essen, Germany, 37 pp. (1971).

After listing all available research data on many aspects of pollution damage, Knabe suggests further "topic-oriented" research, development of new methods, and suggestions and questions submitted by forestry interests to other branches of science and institutes of immission control. He suggests it becomes obvious that a long-term solution of the problem is possible only if the rule of economic growth is replaced by a dynamic state of equilibrium.
Source: 8

#504
Knabe, W. "Air pollution - forest site factor or evil which can be kept off? recommendations for the detection and control of fume damage in a forest-range." Translated from German. Forstarchiv., 42(8/9):172-179 (1971).

Ways in which the forest ranger can assess the effects of fumes on the forest trees are suggested. In judging these effects three cases must be distinguished: single sources, connected areas, and long-range effects. The plant damage that may result from each of these cases is described in detail. Three field methods to clarify suspicion of fume damage in a forest range are described. The first of these involves testing the needles of pine branches for the degree of needle foliage, degree of pollution, needle color, and distribution of damage to the needles. Evaluation of the lichen vegetation on treebark can also provide information about fume damage. Lichens are killed off by very small concentrations of sulfur dioxide, hydrogen fluoride, and hydrochloric acid. The third field method involves determining the pH value of precipitation. The following values are given to aid in evaluating the pH readings: 2.0-3.0 - suspicion of strong effects from acid fumes; 3.1-4.0 - suspicion of slight effects from acid fumes; 4.1-6.0 - no indication for acid or alkaline fumes; 6.1-7.0 - suspicion of slight effects from alkaline fumes, and 7.0 - suspicion of strong effects from alkaline fumes. It is noted, however, that the most reliable proof of fume damage is a matter of scientific investigation by trained experts.
Source: 1

#1460
Knabe, W. "Immissionsbelastung und Immissionsgefahrdung der Walder im Ruhrgebiet." (Pollution and its threat to forests in the Ruhr). Mitt. Forst. Bundesvers., 97:53-87 (1972).

Examples are given of air pollution damage to stands of spruces, pine, and broadleaved species in the forest of the Ruhr region. In the heart of the Ruhr, there are no longer any closed stands of spruce and pine. Although chronic damage occurs to broadleaved and coniferous species in the whole industrial region, the acute damage to the broadleaved species is concentrated in the region containing the chemical factories, aluminum works, galvanizing works, glass factories, and burning tips. The damage is frequently caused by halogen compounds. The causes of chronic fume damage to the forests are sulfur-dioxide, fluorine compounds, oxidants, and dusts, the dust affecting the foliage by blocking light and reducing assimilation, and by affecting the roots by accumulating injurious substances in the soil. The danger of pollution to conifer forests in North Rhine/Westphalia is estimated on the basis of an SO_2 measurement program, the SO_2 being regarded both as an injurious substance and as an indicator of the general air pollution index. The basis for predicting the risk of planting conifers is the frequency of occurrence of certain growing season mean values. In the heart of the region, a growing season mean value of 0.08 mg SO_2/cu m was exceeded in the last 3 out of 4 years, and, in the marginal areas of the region, it was reached or exceeded in 1 year out of 4.
Source: 1

#897
Knabe, W. "Luftverunreinigung und Forstpfalanzen. VIII. Internationale Arbeitstagung forstlicher Rauchsachdensachverstaendiger 1972 in Ungarn." (Air pollution and forest plants 8th international conference of forest smoke damage experts, held in Hungary, 1972). Text in German. Allgem. Forstztg., 10: 196, 198, 200 (1973).

The nature, diagnosis, physiological aspects, and prevention of smoke-induced forest damages were discussed on the 8th International Conference of Forest Smoke Damage Experts held in Hungary, 1972. The diagnosis of forest damages is possible from both visible and hidden alterations of the trees, i. e., the increased acidity of the bark as an indicator of sulfur dioxide induced damages, or above-normal lead, chlorine, calcium, and magnesium contents in bark as indicators of corresponding emissions. Chronic forest damage due to automobile exhaust gases was evidenced. High susceptibility of conifers to ammonia, and relatively high resistance against this substance of Quercus rubra, Quercus robur, Robinia pseudoacacia, and Acer campestre were noted. Intense damage of deciduous woods around aluminum works was observed. The use of resistant species in potential damage areas, nitrogen fertilization, and the application of chlorocholin chloride were cited among the possible measures to be taken to abate smoke damages. The uptake and transport of toxic substances by plants, the effects of toxic substances on plant materials, the combined effect of frost and smoke and draught and smoke, and the resistance-increasing effect of fertilization, and therapeutic measures should be thoroughly investigated in future physiological studies on forest smoke damages.
Source: 1

#1001

Knabe, W. "Zur auswerisung von Immissionsschutz Waldungen." (On establishment of protective forests for air pollution control). Forstarchiv, 44(2):21-27 (1973).

Forests can be used as means of air pollution control and noise abatement because of their ability to improve the environmental quality by absorbing air pollutants, noise waves and radiation besides simply separating industrial areas and traffic lanes from living areas.

The weight of these protective functions of forests have been used in Northrhine-Westphalia as criterion for zoning the state.

The following zones were established: (1) overload zone, (2) load zone, (3) screening zone, and (4) outer sink zone. Protective functions have high priority in zone (1) and both in the need for forest conservation and for forest management. Local protective forests have to be established also in zones (3) and (4), especially along traffic lanes and in the safety belts around large industry works.
Source: 5

#503

Knabe, W., and K.H. Guenther. "Forstwissenschaftliche Beitraege zum Umweltschutz in Nordrhein-Westfalen." (Contributions of forestry to the environmental protection in North Rhine Westphalia). Text in German. Allg. Forstz., 26(24):503-506, 513-514 (June 1971).

The contribution of forestry to environmental protection consists primarily of observations of the effects of air pollutants on trees and plants. The results from indoor exposure test (in greenhouses) do not always reflect the true situation. In open air exposure experiments, young spruce trees grown from seeds were less resistant than scions, whose needles had all the characteristics of those of an old tree. In outdoor gasification experiments, spruces, set up at different levels above the ground, were exposed to the emissions from an aluminum plant. The higher elevated plants were exposed to more fluorine because of greater air ventilation. Tall old trees were injured while young ones growing next to them were seemingly healthy. Although more fluorine was absorbed by the plants, it was eliminated again after some time. In North Rhine Westphalia, forests with an average sulfur dioxide concentration of more than 0.08 mg/cu m during the growing season over three quarters of all measurement years were unsuitable for the growth of any coniferous trees with the exception of Pinus nigra Arn.
Source: 1

#286

Kneip, T. J., M. T. Kleinman, and M. Eisenbud. "Relative contribution of emission sources to the total airborne particulates in New York City." Proc. Int. Clean Air Congr., 3rd, Duesseldorf, West Germany, p. C96-C97 (1973).

Automobile, oil burner, incinerator, sea salt, and soil source fractions for the period February to August 1972 were calculated for the elements lead, vanadium, copper, sodium, and potassium present in New York City aerosol in an effort to employ a mathmematical technique for determining the relative

contribution of emission sources to the total airborne particulates. The method involves determining the concentrations for each selected tracer element and calculating averages for annual, seasonal, and monthly periods. Linear algebraic techniques are used to analyze the data to determine the relative trace element contributions of the sources. Total suspended particulate and corresponding metal concentrations are used over a period for which source fractions are constant, and the corresponding source factors calculated and compared to those originally selected. It may be assumed where disagreement is observed, the original source factors chosen were not correct for the aerosol being studied; and a fitting process can be repeated until an effective set of source factors are generated by resolving the original matrix with calculated factors in place of the original selected factors.
Source: 1

#1462
Knipling, E. B. "Ultraviolet radiation and photosynthesis." Dept.of Transportation, Cambridge, Mass., Transportation Systems Center, Proc. Conf. Clim. Impact Assess. Program, 2nd, Cambridge, Mass, DOT-TSC-OST-73-4. (Available from the National Technical Information Service). p. 379-385 (1972).

The adverse effects of ultraviolet (UV) radiation on photosynthesis are reviewed because stratospheric flights of supersonic transport aircraft may increase the flux of UV radiation reaching the earth 's surface. The UV radiation damages biological systems primarily through destruction of specific cellular constituents rather than alteration of broad physiological processes. Photosynthesis is affected soon after absorption of UV radiation because of its general dependence on cellular integrity and specific dependence on UV vulnerable enzymes and other proteins. Most of the research on UV effects on photosynthesis has been conducted with high intensity radiation at 254 nm, which is shorter than the waveband of concern, 280 to 320 nm. Limited data from the unnaturally high intensities of this waveband indicate a small reduction in photosynthesis of single cell algae.
Source: 1

#340
Knoesel, D. "Vegetation im Bereich von Aufbereitungs und Mischanlagen fuer den bituminoesen Strassenbaul." (The vegetation near asphalt processing and mixing plants). (Presented at the Hohenheim University Umweltforschung Seminar, 1971.) Text in German. Umwetlforschung, 58:22-24 (1971).

Effects of asphalt processing and mixing plant generated emissions (dust, sulfur dioxide, and bituminous aerosol containing mercaptans) are reviewed. Reduced crops, impaired crop quality, discoloration of crops, and corrugation and necrosis of plant leaves due to SO_2 and dust in asphalt processing plant areas were observed. The implementation of strict emission control standards for asphalt processing plants in Germany; the use of centrifugal, tissue and bed filters, electrostatic precipitators, and wet scrubbers, limitation of the maximum allowable dust concentration in waste gases to 150 mg/N cu m; and the use of light, low-sulfur fuel oil and high stacks have had positive effects in terms of reduced plant damages. Investigations so far have failed to give evidence of the phytotoxicity and carcinogenicity of bitumen.
Source: 1

#341

Kobak, K. I. "Issledovaniye potokov uglekisloty kak pokazateley rastitelnogo soobshchestva." [Studying the carbon dioxide currents in the atmosphere as a parameter of vegetal growth]. Tr. Gl. Geofiz. Observ. (Leningrad), 263: 115-118 (1970).

The carbon dioxide concentration profile is determined by the radiation level, the vegetation index, and the coefficient of the turbulent transfer. High vegetation indices result in increased concentration differences on different levels under conditions of homogenous radiation and a slight degree of turbulence. However, increases in the turbulence coefficient lead to reduced differentiation, and the concentration variations in dense vegetations are enhanced by intensified radiation. The minimum of the absolute concentrations can be observed in the afternoon hours on the level of maximum assimilating surface. The minimum CO2 concentration shows typical daily variation. The isopleth density of the CO2 concentration increases with reduced turbulent transfer coefficient. The major part of (53-89%) of the CO2 is absorbed by the portion of the vegetation which possesses the maximum of assimilating surface. The total CO2 current corresponds to the net productivity, while the gross productivity is the sum of the former and the proportion which is used up for respiration during daytime. The vegetal growth is most economical during the period of intensive growth, where the major part of the CO2 assimilated is accumulated in the form of organic matter, while the net productivity corresponds to 60-70% of the gross productivity, and about 80% of the total CO2. As growth slows down, the proportion used up for respiration increases to reach some 50% of the gross productivity. The ratio of the gross to the net productivity in corresponding vegetation in different geographic zones is largely the same, while the respiration loss is less in northern than in southern regions.
Source: 1

#817

Kobayashi, J., F. Morii, S. Muramoto, and S. Nakashima. "Guma-ken Annaka-shi no seirensho ni yoru nosakubutsu nado no juninsoku (Cd, P b, Zn) osen ni tsuite." (Effect of air and water pollution on agricultural products by Cd, Pb, Zn attributed to mine refinery in Annaka City, Gunma Prefecture.) Text in Japanese. Nippon Eiseigaku Zasshi (Jap. J. Hyg.), 25(4):364-375 (Oct. 1970).

In an investigation of air and water pollution by zinc, lead and cadmium discharged from the zinc refinery in Annaka city, Gunma prefecture, agricultural products in the environs were sampled and the contents of the various metals were analyzed. The examinations were carried out twice in October, 1968 and in June, 1969. The quantities were measured by the atomic absorption analysis method. The contents of the metals in mulberry leaves in the hilly regions 400-2500 m east of the refinery were: Cd 17 - 3.3 ppm, Zn 2590-360 ppm, Pb 160-41 ppm and the contents of Cd and Zn showed a regression line, (Zn) equals 141 (Cd) 107, r equal 0.998, indicating a mutual relationship For agricultural products, the results were: fruit vegetables Cd 8.6-0.3 ppm, Zn 150-29 ppm, Pb 11 less than 0.4 ppm, root vegetables, Cd 17-14 ppm, Zn 530-100 ppm, Ph 63 less than 0.02 ppm; leaf vegetables, Cd 61-3.2 ppm, Zn 7010-380 ppm, Pb 370-4.3 ppm. As to barley and wheat, the highest levels were re-

corded as follows: Cd 6.8 ppm, Zn 310 ppm, and Pb 14 ppm. Moreover, the contents of Pb in barley and wheat growing in the fields more than 1500 m below the refinery showed higher levels than those of Pb in barley and wheat growing in the hilly Yaden region, which is 800-1250 m south of the refinery. The fact indicates that the effect of water pollution cannot be ignored. The contents of Cd and Zn in wheat in Yaden and Iwai region showed a regression line, (Zn) equals 41 (Cd) = 50, r equals 0195, indicating significant relationships. Also in Yaden region, higher levels of metals were found in leaf vegetables compared with root vegetables and fruit vegetables and in Annaka city, rice was not the only polluted agricultural product but leaf vegetables were especially highly polluted.
Source: 1

#1463
Kodama, Takenori, Haruhisa Ogita, and Kiyokazu Mizoguchi. "Jidosha haiki gasu ni yoru namari osen." (Lead pollution by auto exhaust gas). Aichiken Kogai Chosa Senta Shoho (Rept. Environ. Pollut. Res. Cent., Aichi Pref.), 1:28-33 (March 1973).

To investigate the relation between traffic quantity and auto exhaust, as well as the horizontal diffusion of lead compounds around the earth, lead contents of soils gathered from various spots in Nagoya were determined by X-ray fluorescence analysis. The average lead value of 50 samples at a crossroads was 215 ppm, and the variation ratio among them was 32%. Samples from parks gave 33 ppm lead, or 115 the content of the crossroad. Lead pollution by auto exhaust gas was proved and the lead content in the earth increased proportionally to the traffic quantity. Soil which has not been polluted contained about 10 ppm lead and crossroad soils contained as much as 20 times that. Horizontal lead diffusion is prevented by trees, and without them dispersion can spread for 200 m. Green belts with abundant trees are effective control measures for auto exhaust gas emissions.
Source: 1

#818
Koeck. "Mildew on oak trees and flue-gas damage." (German). Z. Tflanzen-kranhneiten Pflanzenschultz, 45:1-2 (1935).

The Oak mildew (Microsphaera alni var. quercina) could not be observed at any location which had been exposed to a considerable amount of flue gases containing sulfurous acid. This was especially evident along the southwest slopes of the Haeusel Mountains which are relatively heavily exposed to the flue gases coming from a paper mill in Hinterburg. Absence of oak mildew and similarly the absence of lichen in forests which also contain oaks can be taken as an indicator for the assumption that the region concerned is commonly exposed to flue gases. If one considers the usual control of the genuine mildew fungus by the beans of pulverized sulfa, which transforms under the influence of the atmosphere into sulfurous acid and thus becomes fungicidal, the above observed phenomenon becomes quite understandable.
Source: 1

#391

Koehler, W. "Versuch einer quantifizierung der fuktionen der land- und forstwirtschaft die nicht im produktionsertrag zum ausdruck kommen." [Tentative quantification of agricultural and forestry functions not reflected by production figures]. Allgem. Forstztg., 28:75-76 (Jan. 1973).

Quantification of agricultural and forestry functions not reflected by production figures is attempted. Quantification of such effects and functions as source of employment, equalization of the natural water cycle, protection, recreational attraction, oxygen production, noise abatement and dust filtering especially by forests, is hardly possible due to a lack of relevant data on otherwise complex interrelations. Forests and open spaces are important oxygen producers. A forest area of 1,000,000 ha produce some 15,000,000 tons of oxygen yearly, while the corresponding figure calculated for a comparable open space area is 5,000,000 tons. Forests contribute to noise abatement and dust filtration. A 50 to 100 m broad forest belt is able to reduce the atmospheric particulate content by 50%. Leafy, especially beech, trees are more efficient in their filtration effect than conifers.
Source: 1

#93

Kohout, R. and J. Materna. "Scrpce a sireni kysliciniku siriciteho v asimilacnich organech nekterych lesnich drevin." (Sorption and propagation of sulfur dioxide in the assimilation organs of some forest woody plants). Scientific and Technical Society, Prague (Czechoslavakia), Agriculture and Forestry Section, Proc. Conf. Effect Ind. Emissions Forestry, Janske Lazne, Czechoslovakia, p. XVII-1 to XVII-6 (1966).

The extent of localization of sulfur dioxide in the vegetation organs of plants was investigated. Experiments showed that sulfur dioxide is not absorbed in a uniform manner across the surface of the individual tested leaved trees. Increased concentrations of SO_2, as evidenced in autoradigrams, was observed primarily on the tips of the leaves and along serrated borders, or along the edge of the leaf, mostly in narrow, but sometimes also broad, diffuse zones. The concentration of SO_2 in the tips and borders of the leaves increased within a range of 10-100%. The autoradiograms indicated that penetration of radioactive sulfur compounds into the leaf tissue occurred only with Ulmus effusa and Fagus silvatica. It was also established that sulfur dioxide sorption was highest with Betula verrucosa, Fagus silvatica, and Carpinus betulus. Sulfur dioxide sorption decreased somewhat with Ulmus effusa, Salix caprea, and Robinia pseudacacia. Substantially reduced sorption was observed in Acer platancides, Sorbus aucuparia, Acer campestre, and Populus nigra italica. No definite conclusions were drawn about the sorption of sulfur dioxide by the leaves of trees and the migration of sulfur compounds which arose from SO_2 within the plant organisms. However, it was directly proved that the leaves of many woody plants are really capable of accumulating sulfur dioxide in their marginal portions, even during a very short period, from an environment which contains non-toxic concentrations of the gas.
Source: 1

#306

Koide, Minoru, and E. D. Goldberg. "Atmospheric sulfur and fossil fuel combustion." J. Geophys. Res., 76(27):6589-6596 (Sept. 20, 1971).

Chloride and sulfate concentrations in ice samples from the Greenland ice sheet were spectrophotometrically determined and compared with previously reported values. The analyzed samples were collected in 1964-1965 and were primarily from the Camp Century area and from a virgin site 80 km east-southeast Camp Century. The determined values are uniformly higher than published values; but regardless of the values used, substantial changes in the sulfate-chloride ratios do not appear until 1964-1965. The sulfur dioxide released in the combustion of fossil fuels appears to be competing during the last decade with natural processes such as volcanoes and the oxidation of hydrogen sulfide derived from organic matter. In recent glacial strata, the amount of sulfate co-varies with the amount of lead, suggesting similar source areas and atmospheric paths for the two pollutants.
Source: 1

#1464

Koiwai, A., and T. Kisaki. "Mixed function oxidase inhibitors protect plants from ozone injury." Agr. Biol. Chem., 37(10):2449-2550 (1973).

The effect of mixed function oxidase inhibitors such as SKF 525-A (2-diethylaminoethyl-2,2-diphenyl valerate, DPEA (2,4. dichloro-o-phenylphenoxyethyldiethylamine), DPDA (2,4. dichloro-o-phenylphenoxethyldiethylamine, and piperonyl butoxide on ozone injury to tobacco plants fumigated in an ozone chamber was investigated. The SKF 525-A and DPDA protected leaves by nearly 70%, whereas DPEA was less effective. The protection was nearly proportional to the applied concentrations of the chemicals. The DPDA at 10 mM gave 70 and 80% protection against 50 pphm for 2 hr and 35 pphm for 2 hr of ozone, respectively. The SKF 525-A was less effective than DPDA. The protection rate always showed a higher value against a lower ozone dose than a higher dose. Piperonyl buttoxide was the most effective, giving nearly 100% protection against ozone levels ranging from 30 to 50 pphm over time periods of 1-2 hr. The results suggest that ozone may attack plants through excessive oxidation in some mixed function oxidase-like system(s) including lipid oxidation.
Source: 1

#505

Komai, Y. "Taiki osen ni yoru tojo oyobi shokubutsu no aen shuseki, - Osaka-fu ni okeru chosa." (Zinc accumulation in soils and plants due to air pollution in Osaka Prefecture). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):158 (1971).

The results of survey on zinc accumulations in soil and plants due to air pollution in southern Osaka Prefecture were reported. The quantitative analysis of zinc was by the atomic absorption and x-ray phosphorescence methods. Zinc content in 22 samples of soybean leaves collected from a farm in Saka

city had an average of 300 ppm. The value was approximately five times that in other farms with the same sample of seeds. The averaged total zinc content in the soil of this farm was 170 ppm, of which about 10 to 60% was soluble in 0.1 N hydrochloric acid. This was responsible for the high zinc content in the soybean leaves. More zinc was found in bean plants compared to other plants, and the changes of zinc content in vegetables and soil were larger than the changes of other metal content.
Source: 1

#1465

Komai, K. and S. Sato. "Shokubutsu ni taisuru aryusan gasu to noyaku no fukugo osen." (Complex pollutions on plants caused by sulfur dioxide and pesticides). Kinki Daigaku kogai kenkyusho, kenkyu Hokoku (Kinki Univ. Pollut. Res. Inst. Rep.), 1:9-15 (June 1973).

In order to have some idea of the effects of plants of the coexistence of sulfur dioxide and pesticides, chloroplasts were studied. The Hill reaction and oxidative phosphorylation activities of spinach chloroplasts were measured against treatment with sulfur dioxide and pesticides under both conditions in vitro and in vivo. Moreover, the influence of paedogenesis on chlorophyll biosynthesis and anthocyan pigment biosynthesis was also examined. Spinach chloroplast fragments prepared after SO_2 treatment showed a marked decrease in activities in both the Hill reaction and oxidative phosphorylation conjugate with Hill reaction compared with chloroplast fragments with no treatment. These chloroplast fragments with treatment showed more decrease in activity with the addition of pesticides. The chloroplast fragments prepared after treatment with both SO_2 and pesticides showed a marked decrease in activities in both the Hill reaction and oxidative phosphorylation compared with those prepared after treatment with only SO_2 and those treated with only pesticides. They inhibited stronger reactions with organophosphates than with BHC. Moreover, those treated with both SO_2 and pesticides showed marked inhibition reaction in the biosynthesis of chlorophyll and anthocyan pigment.
Source: 1

#1466

Komeiji, T., T. Sawada, I. Nouchi, and T. Odaira. "Taiki Osen ni yoru toshi jumoku no suitai ni kansuru chosa." (Survey on the decline of urban trees by air pollution). In: Studies on Tokyo Smog. Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, 521-541 (March 1974).

A survey was made to determine the state of yearly decline of urban trees, to compare the local declines considering environmental conditions, to determine the locally characteristic phenomena, and to elucidate the relationship between the decline and environmental factors. The survey was carried out on 9 species (zelkova, ginko, cherry, pasania, white oak, red and black pine, Himalayan cedar, and platanus) in 19 public park gardens in Tokyo. The species which showed conspicuous decline as measured by densities of twigs and leaves were pasania, white oak, red pine, and black pine and the species which showed decline were Himalayan cedar, cherry, ginko and zelkova. Abnormal leaf-fall of zelkova was seen all over the metropolitan area without any differences between localities and period of leaf-fall,

suggesting the influence of oxidant concentration. Necrosis of zelkova and ginko was frequently seen in the metropolitan center affected by primary pollutants such as sulfur oxides, dust-fall, and floating microdust. Necrosis of white oak was due to the compound effect of primary and secondary pollutants. As for the recovery from damage of pasania, the trees in 5 parks in the metropolitan center were over the recovery limit. Those in one park (Shakujii Park) were on the limit. Those in 3 parks did not reach the limit. The percentage age leaf-fall an physiological velocity of leaf-fall were closely correlated. The percentage of leaf-fall was high and the physiological velocity of leaf-fall was low in the locality where plant vigor was declining.
Source: 1

#209
Kortschak, H. P., and L. G. Nickell. "Photosynthetic carbon monoxide metabolism by sugarcane leaves." Plant Sci. Lett., 1:213-216 (1973).

The photosynthetic carbon monoxide metabolism by sugarcane was studied to determine whether substantial quantities of CO are removed from the air by fields in Hawaii. Leaves metabolized low CO concentrations photosynthetically, with sucrose as an end product. Rates of uptake were of the order of 10 to the -4th power mg/d sq m/hr. This was too low to be significant in removing CO from the atmosphere.
Source: 1

#1467
Kotaka, S., A. P. Krueger, and P. C. Andriese. "Catalase activity of a crude enzyme preparation from iron-chlorotic barley (Hordeum vulgaris) seedlings." Nature (London), 204(4964):1198-1199 (December 19,1964).

Air ions of either charge accelerate the development of iron chlorosis in barley seedlings cultivated in an iron-free nutrient solution. The mechanisms involved in this phenomenon were studied. The addition of Fe in the form of Fe-potassium-ethylene-tetracetate (Fe-EDTA) to cell-free extracts prepared from barley seedlings which had developed chlorosis as a result of growth in an Fe-free culture medium in a normal atmosphere produced a marked increase in catalese activity of the extracts. The results indicated that the pattern of increase in catalase activity was related to the extent of chlorosis. The activity of the enzyme preparation made from nonchlorotic barley was not increased by adding 50 ppm Fe, although its initial catalase activity was the highest of those tested. The extract from severe chlorotic barley showed a marked increase in catalase activity after the addition of Fe-EDTA. The peak of activity appeared at 120 min and was followed by a well-defined decrease. The initial activity of this preparation was the lowest of those tested. In the case of recovered seedlings, the increase in catalase activity reached its maximum after 120 min incubation and remained at this level for the entire 6-hour period of observation. The catalase activity of this preparation was slightly lower than that from nonchlorotic seedlings.
Source: 1

#210
Kotaka S., A.P. Krueger, and P.C. Andriege. "Some observation on air-ion-enhanced iron chlorosis in barley (Hordeum vulgaris) seedlings." Plant Cell Physiol., (Tokyo), 6:233-245 (1965).

The air ion effects on "active" and "residual" iron distribution in barley seedlings were studied in the course of the development of ironchlorosis in an iron-free culture nedium. Active or "acid soluble" iron plays an important role for chlorophyll biosynthesis and is extractable with 1.0 normal HCl from dried tissues and "residual" or "acid insoluble" iron does not participate in this chlorophyll formation process and is not extracted with 1.0 normal HCl. Ions of either charge induced a significant decrease in active iron content which was associated with a decrease in chlorophyll content. Concomitantly, there occurred an increase in both the residual iron and the cytochrome c fractions. The increase in residual iron content may involve not only cytochrome c but also other cytochromes and iron-containing enzymeds as well. The authors have proposed a hypothesis that the site of air ion action in the experiments reported may be the regulatory systems controlling iron metabolism in the seed and young seedling. Through this action air ions apparently divert more endogenous free-state iron to residual iron (consisting of cytochromes and Fe-containing enzymes) than to active iron. Tracer experiments showed that air ions enhanced the uptake of exogenous iron by early germination barley seeds. The increased incorporation of iron was not influenced by light.
Source: 1

#1468
Koto, M. and M. Shinozaki. "Yugai gasu ni yoru shokubutsu higai no kaiseki (1) -c. rakuyo kaju ni taisuru ozon, aryusan gasu no eikyo shiken." (Analyses of plant injuries due to harmful gases: Part I. Sec. C. Experiments on the effect of ozone and sulfur dioxide on deciduous fruit trees). Kanagawa-ken Nogyo Sogo Kenkyujo Gyomu Nenpo (Ann. Rep. Kanagawa Prefect. Agr. Integr. Inst.), 1973:72 (June 1974).

Seedlings of 1-year old grafted persimmons of the variety of Fuyu and those of 1-year old cut grapes of variety of Delaware were exposed to ozone at 0.2 ppm for 13 hr., sulfur dioxide at 0.8 ppm for 5 hr, first to SO_2 at 0.8 pppm for 5 hr and then to O_3 at 0.15 ppm for 20 hr, and first to ozone and then to SO_2. No visible injury was observed on the seedlings exposed only to ozone, however, the seedlings consecutively exposed to ozone and then to SO_2 showed many brown spots on the top leaves of persimmons and on the base leaves of grapes. These injuries seemed a little worse than those that appeared on the seedlings exposed at first to SO_2 and then to ozone. The increment of the sulfur content of the leaves was larger in grapes than in persimmons.
Source: 1

#819
Kotte, W. "Rauchschaden an Steinobst-Freuchten." (Smoke damage to stone fruit). Translated from German. Belov and Associates, Denver, Colo., 4 p., Sept. 8, 1970. Nachrbl Deut. Pflanzenschutzdienst (Berlin), 9:91-92 (1929).

Of the fruit trees in the neighborhood of a brickyard, the apples and cherries were undamaged, while in contrast the damson plums, yellow plums, and yellow Victoria plums showed damage on foliage and fruit. Damage symptoms of the damson plums were necrotic spots of tissue that appeared either as sunken patches about fingernail size or, in case of greater extent, as an apical zone of retarded growth. The diseased tissue was coffee brown in color, and beads of sap frequently could be found around the border of the necrotic zone. Microscopic examinations revealed that the epidermal cells were filled with brown granular masses instead of dark blue anthozyan. The pericarpal tissue, which in a healthy condition exhibits vesicular, almost empty appearing cells with transparent walls, was small-celled, with brown colored cellwalls covered with brown granular concretions. Limitation of the damage at the end of the fruits is explained by the fact that here the rain drops hold on longest and the gases dissolved in the water have their strongest influence. The cause of the smoke damage is attributed to hydrofluoric acid.
Source: 1

#820
Koukol, J., and W. M. Dugger, Jr. "Anthocyann formation as a response to ozone and smog treatment in Rumex crispus L." Plant Physiol., 42:1023-1024 (1967).

The red coloration that appears on the leaves of dock plants (Rumex crispus L.) after exposure to smog or ozone was due to the appearance of an anthocyann. The anthocyann was isolated from the leaves of smog treated plants, purified, and identified only as a cyanidin glucoside. The leaves of untreated plants did not contain detectable anthocyann nor did chlorosis occur in the treated plants.
Source: 1

#1469
Koukol, J., W. M. Dugger, Jr., and R. L. Palmer. "Inhibitory effect of peroxyacetyl nitrate on cyclic photophosphorylation by chloroplasts from black valentine bean leaves." Plant Physio., 42(10):1419-1422 (1967).

The inhibitory effect of peroxyacetyl nitrate (PAN) which causes damages to plants by interfering in both photosynthetic and nonphotosynthetic processes on cyclic photophosphorylation by chloroplasts obtained from Black Valentine variety bean leaves is studied in detail. Peroxyacetyl nitrate could oxidize sulfhydryl groups on enzymes necessary for photophosphorylation. The inhibition to photophosphorylation caused by PAN cannot be reversed by glutathone, even when added in large amounts whereas the inhibition to photophosphorylation caused by para-chloromercouriphenylsulfonic acid is easily reversed by small quantities of glutathione. If PAN is oxidizing sulfhydryl groups necessary for photophosphorylation, this oxidation is proceeding beyond the disulfide stage.
Source: 1

#211
Krall, A.R., and N. E. Tolbert. "A comparison of the light dependent metabolism of carbon monxide by barley leaves with that of formaldehyde, formate and carbon dioxide. Plant Physiol., 32(4):321-326 (1957).

Carbon (14) labeled carbon monoxide was used to compare the rate of uptake by barley leaves of four different 1-carbon compounds and also the products of fixation. Carbon monoxide uptake, although very slow, was light dependent. It is incorporated mainly into serine and secondarily into products of the photosynthetic carbon cycle. The carbon monoxide pattern was shirted by 2, 4-dinitrophenol inhibition to one resembling carbon dioxide uptake. Reduction of carbon monoxide may take place on cytochrome oxidase at the time of photodissociation of its complex with the enzyme. Formaldehyde-C(14) fixation in the dark is slow; in the light, it is metabolized several-fold more rapidly. Formaldehyde and formate are fixed into serine, choline, and phosphoryl choline in both light and dark. In light, formate and formaldehyde are also fixed rapidly into products similar to those found from carbon dioxide, while carbon monoxide is converted to these much more slowly. Formate uptake is more rapid than that of either formaldehyde or carbon monoxide.
Source: 1

#511
Kramer, R. C. " Our trees are working too hard." Arborist's News, 37 (1):1-5 (January 1972).

Emphasis is made on damage to trees by air pollution. The future is bleak at this point. Accumulations of evidence are warning us of the predicament we are placing ourselves in. This evidence has been piling up since 1874. One complication with air pollution is that weakened trees become prey to their natural enemy, the pine bark beetle. Steps are set forth to improve the situation.
Source: 2

#282
Kratky, B.A., E.T. Fukunaga, J.W. Hylin, and R.T. Nakano. "Volcanic air pollution: deleterious effects on tomatoes." J. Environ. Quality, 3(2): 138-140 (April-June 1974).

The possible relationship between volcanic fumes and poor tomato crops was investigated in the Kona district of Hawaii. From the winter of 1969-70 to the summer of 1973, severe yield and quality reductions occurred on field grown tomatoes (L. esculentum Mill). There was, a definite atmospheric haze at the time caused by fumes from active and degassing vents located 75 km away and associated with Kilauea Volcano. Tomato plants under plastic rainshelters grew normally. Since rainwater was suspected of causing the symptoms, it was analyzed and found to be acidic (pH 4.0) and to contain appreciable quantities of chloride and sulfate ions plus 27 detectable organic compounds in the ppb range. When tomato leaf discs were immersed in rainwater samples, more calcium, magnesium, and potassium were leached from these acidic samples than from less acidic rainwater samples and the distilled water controls. In a pollen germination medium containing rainwater, pollen germination and tube lengths decreased as the pH of the rainwater decreased. However, since increasing the pH of the acidic Kona rainwater with sodium hydroxide did not increase pollen germination, factors other than pH are suspected to cause poor pollen germination.
Source: 1

#1228
Krebs, E. "Wald und Luft." (Forest and air). Essay - Zurich, Switzerland. Series of newspaper articles, Neue Zuercher Zeitung (August 13, 16, and 17 1965).

This essay deals with the damaging effects of air pollution on forests in a very general manner. Some examples are given of how forestry can cope with the problems, and it is pointed out that well planned and long range forestry is essential in this industrial age.
Source: 6

#1470
Krutikow, A. "Zmiany w biocenozie lasow Krakowskiego okregu przemyslowego." [Changes in the biocenosis of forests in the Cracow industrial area]. Las Polski, 13/1:23-24 (1969).

Changes in the biocenosis of forests in the Cracow industrial area resulting from air pollution due to numerous steelworks, steam-driven electric power stations, paper mills, a cellulose factory, and other industrial plants are documented. The dust deposited on tree crowns contained particles of iron, lead, copper, zinc, and sulfides. The long-time action of gases, dust, and smoke did not increase acidity of the soil but rather decreased acidity of the upper layer. The first evidence of air pollution was the disappearance of mosses on the bark and branches of trees. Pine trees ceased to produce cones and were the most sensitive to air pollution. The changes in pines, beeches, and forest undergrowth are described. These changes altered the population of insects, birds, and mammals living in these forests. Some types of pests affecting pine trees have considerably multiplied; however, foliage of deciduous trees was almost free of damages due to insects. Some type of insects (aphids, etc.) have almost disappeared. The number of ant hills has decreased. Some species of birds (titmouse, flycatcher, kinglets) have decreased although the number of starlings has increased. Squirrels have almost entirely disappeared. The condition of trees has recently improved and needles of pines have the normal color and length. A change in the direction of prevailing winds, increased precipitation, or a possible decrease in atmospheric dust released by industrial plants may account for the improvement.
Source: 1

#821
Kucherov, F.V. and B.E. Fedorako. "Effect of industrial pollutants on the vegetation of Bashkir, USSR." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects and Symptoms of Air Pollutes on Vegetation: Resistance and Susceptibility of Different Plant Species in Various Habitats, In Relation to Plant Utilization for Shelter Belts and as Biological Indicators, M.Y. Nuttonson (ed.), Vol 2, Silver Spring, Md., American Institute of Crop Ecology, p. 19-23 (1969).

Most plants, particularly conifers, are very sensitive to gas pollution which causes arrested growth and changes in the color of leaves and foliage. At small gas concentrations, the edges of leaves curl and foliage yellows, while at higher concentrations burns appear; leaves turn brown and wilt. This causes premature, partial, and complete defoliation. In 1950, various species of trees and shrubs were planted on the grounds of a Russian refinery. Red ash showed a high gas resistance; although its leaves curl, it gives an annual height increment. The leaves of little linden yellow and curl, and those of the European white birch yellow prematurely. Balsam poplar leaves yellow, turn brown, and drop prematurely. Under conditions of prolonged gas pollution of low concentration, all deciduous trees are more resistant than conifers. It is recommended that protective plantings be established near industrial enterprises, in open areas between them, and directly on their grounds. These plantings should consist of thick, multistage trees and shrubs, such as poplar, linden, apple, hedgerow rose, Siberian pea shrub, Tartar honeysuckle, rasberry, and black currant. Such plantings will change the gas composition of the air for the better.
Source: 1

#1471
Kuehl, U. and H. M. Wagner. "Untersuchungen ueber die wirkung von photooxidantien auf Petunia Hybrida." [The effect of photooxidants on Petunia Hybrida]. Staub-Reinhaltung Luft, 30(9):382-383 (Sept. 1970).

The phytotoxic effect of synthetic photochemical smog produced by the irradiation of a mixture of nitrous oxide and propylene with UV light of 320 to 400 nm wavelength on Petunia Hybrida was investigated. The factors affecting the extent of damage were temperature, length of exposure, irradiation and the initial concentration of the reaction partners. Exposure of the plants to gas in a chamber where temperature reached for a short period 40 C resulted in damage to the rims of young leaves, wilting and brown spots after 2 to 3 days. These effects were markedly magnified by a second and third exposure to gas. In contrast, control experiments with air, NO or NO2 or propylene along with simultaneous irradiation did not result in any macroscopic changes. Exposure to gas for 4 to 7 hours resulted in silvery shimmering zones all over the leaf surface. The pallisade cells collapsed first. The decomposition of leaf pigments increased with increased exposure time. With ample light supply and relatively short gas exposure time, damage was reduced or no damage resulted at all. The plants clearly manifested an increased sensitivity to damage under diffuse light conditions. An increase in the concentration of either or of both gases increased the amount of damage.
Source: 1

#390

Kuehn, H. and N. Faller. "SO2 in the atomsphere and its role in sulfur nutrition of plants." Proc. Int. Symp. Sulphur Agric., 1970, 265-273 (1972).

The role of atmospheric sulfur dioxide in the sulfur nutrition of plants is reviewed. Observations in West Germany indicate that in spite of the relatively low amounts of sulfur brought into the soil by fertilization, and in spite of well known losses by leaching, crop sulfur supply is well assured to the release of huge amounts of gaseous sulfur dioxide as a result of the combustion of sulfur-containing fuels. The total annual sulfur dioxide emission in West Germany is about 4 million tons and is equivalent to an average of 240 kg of sulfate per hectare. Plant chamber experiments using labeled sulfur dioxide show increased yields for sunflower, maize, and tobacco at 0.2 mg of the gas; all of the plants display the uptake of sulfur dioxide from the air for production of dry matter. Plant sulfur uptake is an essential factor in the reduction of undesirable amounts of atmospheric sulfur dioxide.
Source: 1

#824

Kulagin, Y.Z. "Moisture Conditions and Gas Resistance of Woody Plants." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects and Symptoms of Air Pollutes on Vegetation. Resistance and Susceptibility of Different Plant Species in Various Habitats. In Relation to Plant Utilization for Shelter Belts and as Biological Indicators. M. Y. Nuttonson (ed.), Vol.2, Silver Spring, Md., American Institute of Crop Ecology, p.41-43 1969. (Also: Akad, Nauk SSSR Ural. Filial, Komis. po Okhrane Priordy. Rastitel nost ipromyshlennye zagryazneniya. Okhrana prirody na Urale, V. (Sverdlovsk, 1966), p. 49-51.

The relationship between water conditions of woody plants and their gas resistance is important in selecting gas-resistant species on the basis of the specific water conditions and degree of drought resistance. There is an opinion that drought-resistant trees are also gas-resistant. A number of species differing in their degrees of drought resistance and the nature of water conditions were studied. The gas resistance of the leaves of the selcted species varies. Sulfur dioxide damaged larch needles 100%; pea tree leaves, 80%; European white birch leaves, 50%; and pubescent birch leaves, 70%. Thus, the larch and pea tree, although most drought-resistant, are least gas-resistant. Not all drought-resistant species are also gas-resistant. The only resistant species are those whose leaves have a xeromorphic structure. Toxic gases, when injuring susceptible trees, affect the water conditions of the leaves by lowering the bond water content and their water retention capacity, and thus, their drought resistance.
Source: 1

#823

Kulagin, Y.Z. "Smoke resistance of woody plants as an ecological problem." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects and Symptoms of Air Pollutes on Vegetation. Resistance and Susceptibility of Different Plant Species in Various Habitats. In Relation to Plant Utilization for Shelter Belts and as Biological Indicators. M. Y. Nuttonson (ed.), Vo. 2, Silver Spring, Md., American Institute of Crop Ecology, p. 32-34 (1969). (Also: Akad, Nauk SSSR Ural. Filial. Komis. po Okhrane Prirody. Rastitel nost ipromyshlennye zagryazneniya. Okhrama prirody na Urale. V. (Sverdlovsk, 1966), p. 25-27.)

The ecological factor of smoke resistance in woody plants was the basis of investigations in areas surrounding metallurgical and petroleum refineries. Conditions of smoke pollution should be distinguished by considering the physicochemical properties of the toxic components of the smoke, the intensity of gas and dust effects, the frequency of their occurrence during the growing period, and their annual recurrence. This ecological concept requires a recognition of the critical periods when the sensitivity to toxic components is greatest. The critical periods are connected with weak morphological defense of tender shoots; inability to regenerate leaves; and injury followed by unfavorable weather conditons. The critical period for conifers dusted with magnesium oxide is early summer, when the needles are being formed. A sulfur dioxide attack in early or midsummer is lethal for pine, spruce, lilac, and other species with a weak leaf regeneration capacity. A late summer exposure ot SO_2 is not injurious. Smoke from industrial plants should be considered as an ecological factor. The degree of toxicity of industrial gases depends greatly on the surrounding atmospheric conditions. The survival and regeneration of tree is determined by the maturity of the shoots and their resistance to the subsequent weather conditions.
Source: 1

#822

Kulagin, Y.Z. "Gas Resistance of Pine and Birch." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature, Volume III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union. M. Y. Nuttonson (ed.), Silver Spring, Md., American Institute of Crop Ecology, p. 51-57 (1970). (Also: Ilhrana Prirody na Urale, 4:115-112 (1964).

Smoke injury to forests and their destruction under the conditions existing in the Southern Urals are intimately connected with the zonal climatic conditions, and, above all, with the weather during the growth season. European white birch and partly Scotch pine can thrive satisfactorily under conditions of intermitten severe sulfur dioxide attacks of short duration. Their gas resistance is conditioned by the occurrence of these attacks in the secondhalf of the vegetation season. Normally, rainy weather, together with changeable winds and low barometric pressure, occurs in July and pushes the noxious gases down close to the ground. Westerly winds prevail in the area under consideration, in the environs of the city of Karabash and its copper smelter. The growth and formation of shoots is almost complete during May and June; the absence of the so-called biological gas resistance but high drought and frost resistance of defoliated birch and pine shoots insures their viability in late summer, autumn and winter, and resurgence of vegetation processes the following season.
Source: 1

#1268

Kunte, Helga. "Kanzero anzerogene Substanzen in Wasser und Boden. XVIII. Die mittels Misch Dunnschichtchromatogtaphie und Fluoreszensmessung." (Carcinogenic substances in water and soil. XVIII. The determination of polycyclic, aromatic hydrocarbons using combined thin-layer chromatography and fluorescence measurement). Arch. Hyg. Bakteriol. (Munich), 151(3-4):193-201 (August 1967).

A method is described for the separation of polycyclic, aromatic hydrocarbons from extracts of water, soil, and dust by two-dimensional mixed thin-layer chromatography and their quantitative determination by fluorescence measurement. The behavior of these compounds is described: pyrene, fluoranthene, 1, 2-benzanthracene, 3,4-benzyprene, 3,4-benzfluoranthrene, 10, 11-benzfluoranthrene, 11,12-benzperylene. These hydrocarbons are detected at concentrations of 0.05-1.0 micro./mi. at wavelengths from 400 to 650 milli microns. This study was limited by the use of 365 milli microns as the standard wavelength. Limitations, such as reduced intensity, possible errors, and correction factors are discussed. The simplicity, speed, and sensitivity of the method recommend it.
Source: 1

#586

Kurata, Masujiro and Akira Hashimoto. "Engaichi no soki fukkyu ni kansuru kenkyu. Ashio no engai hadakachi fukkyusaku ni tsuite." (Study of early recovery in smoke damaged areas. II. Policy in the smoke-denuded area in Ashio (Central Honshu)). Nihon Ringaku Taikai Koenshu (Proc. Japan. Forestry Soc.), 1956: 261-264 (1956).

Plants containing a lot of nitrogen can withstand damage from smoke. A nitrogen analysis of plant leaves was made of plants in a smoke-denuded area, only 100 m for the smoke source of the Ashio Mine. The area damaged by the smoke damage of July 11-12, 1955, was also investigated. The recovery of both smoke damaged areas is described. In the steeply sloping area like Ashio, where it is very cold, the ground would keep eroding, by frost, rain, and wind, and freezing, thus causing denuding, even when there was no smoke damage; and a large forest fire caused one area to be completely denuded, due to smoke damage. The area where the denuding is discontinuous could be turned into a green area by avoiding the transfer of earth and sand. Unless the transfer of earth and sand is prevented, even if the automatic smelting facilities are completed and no gas is emitted, the recovery of the denuded area will not be easy. Maebashi Forestry Bureau succeeded in turning the Fukazawa area into green, by planting grass and trees on the denuded area. The plants rich in nitrogen can withstand smoke, and also grow on lean ground. Sufficient fertilizer must be applied, and evergreen grasses should be grown. The same sort of consideration should be paid to the recovery of Kosaka, Naoshima, Hibi, and other smoke-damaged areas.
Source: 1

#1472
Kuribayashi, Shigeharu. "Fukkabutsu ni yoru taiki osen no yosan ni oyobosu eikyo." (Influence of air pollution with fluoride on sericulture). Nihon Sanshigaku Zasshi (J. Sericult. Sci. Japan), 41(4):316-322 (Aug 1972).

The effects of fluoride on mulberry leaves and silkworms are reviewed. Fluorine emission sources are discussed. The damage symptoms of mulberry plants vary by degrees, but main characteristics include tip burn, chlorosis of leaves from the edges toward the center, withering, warping, and dropping of leaves. Mottling, banding, and the appearance of shininess or a white powder-like substances are some other symptoms. The normal F content in mulberry leaves is 10-20 ppm. When exposed in 1.5 ppb hydrogen fluoride for 118 hr. no visual damage appears, but further exposure for 212.6 hr will cause visual damages. For a slow accumulation of F, the leaves show a relatively high tolerance, and the F content in the leaves can be as high as 273 ppm when the damages begin to show. When exposed to 5 ppb gas for 40.6 hr, visual damages appear, and the F content can be as high as 213 ppm. A vast variety of damages and concentrations are reported. Silkworms can be damaged either by the consumption of high concentrations of the F in mulberry leaves, or by accumulation of F by consumption of low concentrations of F over a long period. The damage mechanism is not clear, but F seems to suppress the enzyme function and disrupt the respiration of the body system. An acute poisoning usually causes inactivity and death. Chronic effects can delay the growth of the silkworm, or cause lack of sleep, softening of the body, decrease of weight, formation of knots, black mottles, or virus. The tolerance of silkworms for F is usually in the range of 24 to 40 ppm (in dry mulberry leaves.)
Source: 1

#1474
Kusaka, Shoji, Tamao Imai, and Fumiyuki Asakawa. "Setouchi engan ni okeru okishidanto aryusan gasuto fukugo osen ni yoru sasairui no genchi higai jittai chosa (1)." (The inland sea coast on-site investigations of vegetable damages by complex pollution of oxidants and sulfur dioxide (Part I)). Hyogo Kenritsu Nogyo Shikenjo Gyomu Kotei. 1972 (Annu. Rep. Hyogo Prefect. Stn.), 1973:1-8 (1973).

To examine the causes for the frequent produce damages along the coast of Inland Sea, various types of scallions were planted in Takarazuka, Akashi, and Takasago, and the growth, damages, and relationship with air pollution were examined. In all experiments, brownish-white tip burn from 5 to 20 cm long were noted. The discoloration and burn damages were more serious on old leaves, but the growth impairment was generally more prominent for younger scallions. The sulfur content in the plants were highest in the order of Takasago, Takarazuka, and Akashi. Especially in plants planted in June, the total sulfur content in new leaves increased drastically. The atmospheric sulfur dioxide concentration was generally low, but the level of pollution was highest in the order of Taskasago, Takarazuka, and Akashi, and agreed with the sulfur content in scallion leaves. In Takasago, the number of hours with more than 0.05 ppm concentration was much longer than other cities. Oxidant concentration was generally less than 0.05 ppm, but the maximum figure exceeded 0.2 ppm. The level of oxidant pollution was greatest in the order of Akashi, Takarazuka, and Takasago, the reverse of SO_2 pollution, but the length of time with more than 0.1 ppm concentration was the longest in the order of Takasago, Takarazuka, and Akashi. The effects of SO_2 or oxidants could not be determined singly on the scallions. But a complex effect of low concentration SO_2, oxidants and various biological factors of growing plants was suspected.
Source: 1

#1475
Kusaka, Shoji, Tamao Imai, and Fumiyuki Asakawa. "Setouchi engan ni okeru okishidanto, aryusan gasuto fukugo osen ni yoru yasairui no genchi higai jittai chosa (2)." (The inland sea coast on-site investigations of vegetable damages by complex pollution of oxidants and sulfur dixoide gases (Part II)). Hyogo Kenritsu Nogyo Shikenjo Gyomu Kotei (Ann. Rep. Hyogo Prefect. Agr. Exp. Stn.), 1973:11-16 (1973).

Heavy damages of scallion leaves were reported in June 1972 in Himeji; air pollution damages were suspected and an on-site investigation was conducted. Soil and plant samplings were analyzed for sulfur content and pH, and air pollution data of the Himeji air pollution monitoring stations were examined. The weather between June 1-20 was mostly cloudy with variable amounts of sun, and temperature differences were strong. The 24-hour sulfur dioxide concentration averages were mostly less than 0.05 ppm, with some high concentrations of 0.10 ppm or more for various single measurements. The oxidant level was within 0.01-0.02 ppm in general for the period and there was no conspicuously high measurement anywhere. In the investigated area, the entire field of scallions had heavy tip burn, but no other produce were damaged. The soil pH ranged between 5.8 and 7.4, and the sulfur content in scallions was higher than produce in control areas. Damages were not likely caused by any single effect of oxidant or SO_2.
Source: 1

#1473
Kusaka, S., T. Imai, and F. Asakawa. "The inland sea coast of on-site investigations of vegetable damages by complex pollution of oxidants and sulfur dioxide (Part III). Text in Japanese. Hyogo Kenritsu Nogyo Shikenjo Gyomu Kotei, 1972 Annu. Rep. (Hyogo Prefect. Agric Exp. Stn.), 1973:18-12 (1973).

The damages of scallions that occurred inTakarazuka in early October 1972 were examined on site. On October 3, a sudden change was noted on the leaves of scallions; the usual green color turned yellow and the leaves withered, finally turning silver-grey and dying. An examination of meteorological data and pollution data showed that between September 27 and October 3, the level of oxidant concentration was unusually high. Between October 1 and October 3, the average between 9 am and 6 pm was over 0.1 ppm, with the maximum of 0.168 ppm. The product was exposed to an average of 0.1 ppm oxidants for a least 10 hr. The level of sulfur dioxide in the air did not change dramatically during this period, but it tended to be high during the day, with hourly averages of 0.065 ppm and 0.054 pppm on September 28 and October 1. The scallion damages were assumed to be the effect of the oxidants.
Source: 1

#1493
Laamanen, A. and R. Lahdes. "Observations on the sulphur content of pine needles from the environment of point and area sources." Work-Environ-Health, 6(1):41-43 (1969).

Sulfate analyses were carried out on needles of pine trees in the environment of a sulfite cellulose factory and a district heating installation using heavy fuel oil. Equiconcentration isopleths of SO_4 with a valence of minus two were drawn on a map of the region. A negative correlation between the distance from the source and the sulfite concentration in the samples was noted.
Source: 1

#1494
Laboratory for Analyzing Fertilizer, Chemical Div., Institute for Agricultural Sciences, Ministry of Agriculture and Forestry (Japan) Fertilizer Analysis Lab. "Aryusan gasu o kyushu shita shokubutsu- chu no io no bunpu to keitai." (Distribution of sulfur and its morphology in plants which have absorbed aerial SO2 gas). Norinsho Nogyo Gijutsu Kenkyusho Nenpo (Ann. Report Inst. Agric. Sci., Minist. Agric., For.), Fiscal 1971:15-20 (Dec 1972).

The distribution of sulfur dioxide adsorbed from stomata of plants in the body of the plant and methods of analyzing the sulfur compounds in the plant were investigated. Potted plants of rice, salting greens, leaf mustard, and soya were exposed to aerial SO_2 in concentrations of 0.25, 0.3 and 0.8 ppm daily for 5-10 hr until symptoms appeared on the leaves. The ratio of water soluble sulfur compounds to total sulfur was larger in exposed plants than in controls. When the difference of sulfur in exposed plants and in controls was assumed to be the sulfur which came from absorbed SO_2 and its water solubility was calculated, it was 75-100%, showing that the sulfur absorbed from stomata as SO_2 existed in the plants as water-soluble forms, possibly sulfuric or sulfic acid. The water soluable sulfur had a higher correlation with aerial concentrations of SO_2 than total sulfur and it was possible to identify the pollutant by analyzing water-soluble sulfur as well as total sulfur. According to the analytical data of sulfur-containing amino acids in the exposed plants, the intake of sulfur from SO2 to plant protein was largest in salting green (11.5%) and smallest in soya (1.9%), suggesting that the absorbed SO_2 changed to water-soluble form and remained in that form for at least 1 week with a very small amount of intake into plant protein. In another experiment in which tomato, cucumber, soya, Zelkova, and red pine were exposed to $^{35}SO_2$ for 5 hr at the average concentration of 0.5 ppm, ^{35}S was distributed mainly in growing active leaves, rather than in old leaves and the distribution decreased in the following order: leaf blade, petiole, stem and root.
Source: 1

1495

Lacasse, Norman L. and T. Craig Weidensaul. "A cooperative extension-based system of assessing air pollution damage to vegetation: organization, results, and recommendations for future studies." International Union of Air Pollution Prevention Associations, 17 p. (1970). Presented at the International Clean Air Congress, 2nd, Washington, D.C., Paper SU-30G (Dec 6-11, 1970).

A statewide survey of vegetation damage caused by air pollution was initiated in 1969 to assess economic losses incurred on food, fiber, and ornamental crops in Pennsylvania. Cooperative Extension Service personnel, nursery inspectors, and service forestors provided the specialized manpower for field investigations. Their reports were evaluated by a plant pathologist. Estimates of damage (direct losses) were based on crop value and production cost. Profit losses, losses resulting from crop substitution and relocation costs (indirect losses) were tabulated seperately. In the first year of the survey 60 out of 92 investigations in 28 countries revealed damage attributable to air pollution. Vegetables, fruits, and agronomic crops were most seriously affected, accounting for more than 3.2 million dollars in direct losses. Damage to lawns, shrubs, and woody ornamentals resulted in losses of more than 200 thousand dollars, while timber losses exceeded 39 thousand dollars. Total direct losses were in excess of 3.5 billion dollars; indirect losses were 8 million dollars. It is emphasized that these figures do not represent an annual loss and that tabulation of losses on a county-by-county basis does not lead to a national cost estimate. The survey is continuing in 1970 with two major changes: verification of plant damage by chemical tissue analysis and inclusion of greenhouse crops during winter months.
Source: 1

#1266

Lagerwerff, J.V. "Heavy-metal contamination of soils." American Assoc. for the Advancement of Science, Washington, D.C., Agr. Qual. Environ., 343-364 (1966).

A soil is contaminated when foreign substances are introduced into the plow lager damaging the quality or quantity of crops produced. The five major sources of heavy metals are aerosols, pesticides, limestone or phosphate fertilizers, manures and sewage sludge, and mine waste. Heavy metals considered are copper, zinc, manganese, nickel, aluminum, mercury, cadmium, and lead. The interrelated factors of Ph and microbial activity determine the equilibrium between the mobile low-valency forms and the less mobile high- valency forms. To some extent the metals occur as chelates by accumulating biologically in living systems or by reacting with soil organic matter. The usual order of decreasing competition with Fe is Cu, Co, Ni, Cr, Zn, Mn, Pb. The toxicity to plants does not necessarily follow this order. Phosphates of the metals are insoluble in high PH. Unfavorable effects on plants can usually be alleviated by liming, stubble mulching, or application of phosphates until the Ph is at or above 6.5. Foliar or direct application of Fe alleviates unfavorable effects in some cases. Absolute values for treatments depend on plant species and ecological conditions.
Source: 1

#343
Lagerwerff, J. V. "Discussion. Air as a source of lead in edible crops." Environ. Sci. Technol., 4(3):230 (March 1970).

The conclusion from a previous experiment that under prevailing experimental conditions, most lead in plants is derived from soil and arterial Pb plays a very minor role was evaluated. The rate at which the plants respond to the Pb present in the environment under the general conditions established was discussed, particularly the question of whether the accumulation of Pb by plants was measured on a steep or on a flat part of the curve, characterizing the relationship between uptake rate and such experimental variables as Pb concentrations in soil and air or air movement in the greenhouse and distance from traffic observed in roadside studies. The net outcome may diminish differences in Pb content that otherwise would occur between plants exposed to the two aerial concentrations of Pb applied. With regard to completeness of data, no measurements were made of crop yield and by implication, on total uptake of Pb by plants. Soil pH values also were not reported. Data interpretation was also questioned. In discussing the accumulation of Pb by sweet corn grown in the greenhouse, it was stated that the cob contained a higher concentration of Pb than the kernel, and that this distribution would be difficult to explain if the source of the lead were not the soil. This conclusion presumes the knowledge of the pathway followed by Pb taken up by the roots. In stressing the importance of soil-borne Pb relative to that of airborne Pb with regard to the composition of plants grown in roadside soils, the long-term, indirect effects were emphasized rather than the short-term, direct effects of aerial Pb. The broader ramifications included the significance of the effects of aerial Pb on the quality of our food.
Source: 1

#344
Lagerwerff, J. V. "Uptake of cadmium, lead and zinc by radish from soil and air." Soil Sci., 111(2):129-133 (Feb. 1971).

Soil was sampled at 3 locations at both 7 meters and 200 meters from a heavily travelled road. The extractable metal contents, which were high and low, respectively, were determined by shaking 20 g of air-dry soil with 40 ml N hydrogen chloride for 1 hour, collecting a centrifugate, and analyzing by atomic absorption spectrophotometry. Nine-hundred gram batches of soil were put in half-gallon cardboard containers lined with polyethylene; radish was sown and the seedlings were thinned to nine plants per container and grown to maturity. Large changes in the soil contents of cadmium, lead, and zinc caused only small changes in the only small changes in the contents of these metals in radish. Increasing the soil pH from 5.9 to 7.2 resulted in decreases in yield and metal contents of the plants. Grown at 200 meters from a busy highway, aerial contamination accounted for more than 40% of the Pb, Cd, and Zn of the radish tops. Only Zn was translocated to the roots to a significant extent.
Source: 1, 6

#1267

Lagerwerff, J. V. "Current research in heavy metals in soil, sediment and water: January 1973-October 1974." California Univ., Berkeley, Lawrence Berkeley Lab. and National Science Foundation Research Applied to National Needs, Trace Contam. Conf. Proc., Annu.,2nd, Pacific Grove, Calif., p. 16-47 (August 29-31, 1974).

Cadmium, copper, mercury, manganese, lead, and zinc are discussed in relation to analytical techniques, sources of contamination, flow through the ecosystem, accumulation in soils and sediments, uptake by plants, and abatement. A general section deals with heavy metals as a group.
Source: 1

#389

Lagerwerff, J. V., W. H. Armiger, and A. W. Specht. "Uptake of lead by alfalfa and corn from soil and air." Soil Sci., 115(6):455-460 (June 1973).

Growth and lead uptake by corn and alfalfa were measured in potted chester silt loam at two soil pH levels (5.2 and 7.2)and with hydrogen chloride-extractable soil lead levels of 12, 64, 113, and 212 ppm. Most treatments were carried out in a greenhouse. In addition to aerial lead associated with nearby heavy traffic, fallout of particles of leaded paint constituted a contamination hazard. The control treatment of corn was also carried out at a nearby outside location, but in the absence of leaded-paint particulates. While the fallout of lead was three times heavier inside than outside, the aerosol lead concentration outside was almost twice as large as the one inside. The latter was reflected by the tassels only. All other plant parts, especially in the upper plant section, reflected the heavier lead fallout inside than outside. The plant parts in the lower plant section distinctly reflected increases in soil lead content. Rinsing the tops of alfalfa removed more lead from plants growing on unlimed soil than from those on limed soil. The amount of level so removed from the tops increased as more lead was taken up from the soil, suggesting translocation of lead from the roots to the tops.
Source: 1

#1496

Lagerwerff, J. V., D. L. Brower, and G. T. Biersdorf. "Accumulation of cadmium, copper, lead and zinc in soild and vegetation in the proximity of a smelter." Missouri Univ., Columbia, Environmental Trace Substances Center and Extension Div., Trace Subst. Environ.Health, Proc. Univ. Mo., Annu. Conf. 6th, Columbia, Mo., p. 71-78 (June 13-15, 1972).

The occurrence of the elements cadmium, copper, lead, zinc, and manganese in soils, and the first four elements in natural vegetation (grass) is studied, with samples taken in an area of about 10 sq mi located mostly to the north of the smelter. The concentrations of Cd, Cu, Pb and Zn in soils and plants

decreased with increasing distance from the smelter, indicating the possible location of the source. Analysis of the soil profile established a negative relationship between metal concetration and depth. This suggests an aerial origin of the contamination. Soil samples were also collected in enclosed spaces under houses (protected soil), as well as around these houses (unprotected soil). The average ratios between the metal concentrations in the 0-20 centimeter layers of unprotected soil and comparable metal concentrations in the protected soil are 7.0 for Cd, 2.9 for Cu, 2.0 for Mn, 2.3 for Pb and 4.8 for Zn. These values serve as a general measure depicting the metal accumulation in the exposed soil. Coupled with the low pH, a deterioration of the quality of the soil in a region with a high native metal background level is indicated. Heavy metal accumulation in surface soil resulting from aerial contamination, in conjunction with high native background concentrations and low pH levels that favor solubility and plant uptake, may have caused the presence of an environmental hazard. Uptake of these heavy metals by plants may cause extensive toxicity to vegetation and human health.
Source:1

#342

Lagerwerff, J.V. and A.W. Specht. "Occurrence of environmental cadmium and zinc, and their uptake by plants." Proc. Missouri Univ. Fourth Annual Conf. Trace Substances Environmental Health, Columbia, Mo., 85-93 (1970).

Cadmium occurs in air and water as the result of a number of identifiable processes and practices, mainly industrial and agricultural. The metal reaches soil and plant cover directly or indirectly as a result of these activities, a number of which are discussed. Cadmium thus enters the food cycle absorbed by the foliage or the roots of plants. Data indicate the presence of Cd in many common foods. The presence of Cd is usually linked to that of zinc. Soil samples were collected next to two heavily travelled roads. Analysis showed that Cd and Zn concentrations in soil and vegetation decreased with distance from the road, indicating their relation to traffic (motor oil and tread wear from tires). However, high concentrations of one metal do not always entail high levels of the other. The uptake of Cd and Zn by bromegrass as a function of soil concentration, soil Ph, and air quality was studied and, using radish, the importance of atmospheric cadmium was weighed against cadmium from soil as a source of contamination. The feasibility of minimizing the uptake and translocation of cadmium by means of zinc or calcium was examined.
Source: 1

#1432

Lahmann, E. "CO-Konzentrationen im Berliner Stadtgebiet (Strassen, Tunnels, Wohngebiete und Gewaesser)." (Co concentrations in the city of Berlin (In streets, tunnels, residential areas). Staub, Reinhaltung Luft, 32(2):74-77 (Feb. 1972).

At six measurement stations located in Berlin at different altitudes (at 0, 75 cm, 1.5, 3, 6, 12, and 24 m), the average carbon monoxide concentration was measured in 1965-1971. The CO decreased linearly when the height in which the measurement was taken was plotted in logarithmic scale. Of the concentrations measured, 93% were measured at 1.5 m, 79% at 3 m, 68% at 6 m, 58% at 12 m, and 44% at 24 m above the ground. By a road with heavy traffic, the maximum half-hour value was 61, and the maximum daily average was 32 ppm CO. In tunnels the measured CO content was over 100 ppm (half-hour average). Far from road traffic, CO increased by 20 ppm in 10 hr as a result of steady weather conditions. On lakes with motor boat traffic, a maximum half-hour average of 10 ppm CO was reached.
Source: 1

#264

Lakin, H. W. "Selenium in our environment." (Presented at the American Chemical Society, Division of Water, Air, and Waste Chemistry Meeting 162nd, Washington, D. C., Sept. 15, 1971.) Advan. Chem. Ser., 123:96-111 (1973).

A review is presented on the natural and manmade sources of selenium in the environment. The primary sources of Se are volcanic emanations and metallic sulfides associated with igneous activity, while secondary sources are biological sinks in which the metal accumulates. The Se content of black shales, coal, and petroleum is 10-20 times the crustal abundance (0.05 ppm). Seleniferous black shales are the parent materials of the widespread seleniferous soils of the western plains of the United States. The average Se content of coal in the United States is about 3 ppm, while petroleum contains about 0.2 ppm on the average; when burned, Se-containing coal and petroleum give rise to a redistribution of particulate Se and selenium oxide. The burning of fossil fuels in the United States is estimated to yield 8,000,000 lbs of Se annually as an air pollutant. The Se content of streams is a function of the presence of Se in the drainage system and of the pH of the stream water, with major rivers averaging about 0.2 micrograms/l of Se. The Se content of seawater averages 0.09 micrograms/l. Selenium in the atmosphere as measured by the Se content of snow is a function of the industrial activity in the vicinity of measurement.
Source: 1

#111

Lamanna, C. "Influence of vegetation in the urban environment on air pollution." Bioscience, 20:201-202 (1970).

A discussion of the feasibility of using vegetation to reduce air pollution in urban areas. Briefly describes mechanisms by which plants reduce air pollution and the possibilities for increasing this ability, i. e., increasing plant resistance. Makes a series of recommendations for actions in this area to be carried out by Federal agency.
Source: 7

#1498

Lampadius, F. "Vorbeugung gegen Rauschschaeden im Walde durch forstliche Massnahmen (dargestellt am Beispiel des Rauchschadengebietes St. Egidien am Fusse des Erzgebirges)." (Prevention of smoke damage in the forest by forest measures (based on the example of the smoke damage area of St. Egidien at the foot of the Erz Mountains)). Forst Holzwirtschaft, 13:255-259 (July 1, 1960).

The establishment of a foundry at the northern edge of the Erz Mountains basin portends an increased smoke damage threat for a forest region northeast of the foundry site. Sulfur dioxide emissions from the foundry will be 34.1 tons/day if West Eibe coal is used for 16.8 tons/day if East Eibe coal is used. A forest transformation project designed to avert a smoke damage crisis is based on planting approximately 51.5 hectares of forest with smoke-resistant trees in four 10-year periods (1958-1997). Smoke-resistant species were determined in an investigation that included visual observation of present smoke damage to individual stands and atmospheric sulfur and dust measurements using Liesegang bell jars. Depending on distance from smoke sources, terrain formation, and weather phenomena, sulfur values ranged from 4.04-80.65 mg/100 hr. In forest areas midway between existing SO2 sources and the foundry site. Liesegang filter sulfur values were 20-25 mg/100 hr. Dust measurements in front of and behind the foundry were 11,000-92,000 particles/l. Extensive smoke damage to particularly sensitive trees (e.g. fir and spruce) was observed in section where air masses from the principle wind direction came into collision with forest ridges or stand ridges. Smoke damage was also apparent in forest areas where the terrain rose in a northeasterly or easterly direction. The most resistant trees were larch Weymouth, pine, and black pine. Parent stands of these coniferous trees which meet the requirements of seed production are located near the transformation area. Deciduous trees suitable for the transformation project are principally mountain oak, common oak, red oak, and beech; from time to time these will be supplemented by aider, linden, maple, hornbeam, ash, poplar, and birch. The first phase of the transformation will cover the collision areas and those forest surfaces which due to their terrain, are expecially exposed to the smoke effect.
Source: 1

#1236

Lampadius, F. "Problematik und Methodik groBräumiger Luftuntersuchungen." (Problems and methods in the mesoscale examination of the atmosphere). Wiss. Z. Techn. Univers. Dresden (Herausgeber: Der Rektor), 11(3):609-616 (1962).

In the past, a few isolated emission sources were the cause of air pollution damage in forests. However, during the last 2 to 3 decades, the emissions of industrial sources have increased the threat to much larger forest areas. Therefore, the analysis of air pollution in the damaged forests has to be done on a larger scale; in some cases over areas up to several hundred square km. The diagnosis of air pollution damage in these large forest areas (which has to precede treatment in most cases) can be approached in

two ways: either stationary and continually over long periods, or mobile and intermittently over short periods. With both methods, it is difficult to extrapolate from a measuring point into the surrounding area. However, the selection of the method had to depend more on the use of adequate measuring devices, than on principles of methodology. For forest air pollution research in Middle Germany, the improved aero-analytical summation method (Wislicenus) is used, but this method has the known weakness of not clearly showing peak concentrations of air pollution. However, for specific forest problems, it was found to have great practical advantages in atmosphere studies over large areas. It has proven to be useful to supplement studies using mobile and intermittent measurements to fix the distance to the smoke source, and the associated concentrations, at which a toxicity threshold is exceeded.
Source: 6

#1238
Lampadius, F. "Ergebnisse von Bestimmungen des Schwefeldioxydgehaltes der atmosphärischen Luft mit einem auf der Pararosanilinmethode basierenden MeBkoffer." (The sulfur dioxide contents of the atmosphere measured by the pararosaniline method). Wiss. Z. Techn. Univers. Dresden (Herausgeber: Der Rektor), 12(5):1585-1594 (1963).

Among the toxins (emitted by industry, home heating, and means of transportation) polluting the atmosphere, sulfur dioxide is the most important when studying air pollution damage on agriculture and forests. This is because plants are highly sensitive to SO_2. Keller and Müller have shown that the toxicity threshold for pines lies at about 0.4 to 0.5 mg/m^3 air. The threshold for the human nervous system has been determined to be 0.6 mg/m^3 air. Tests performed by Haut, Guderian, and others have shown that SO_2 damage to plants - aside from the stage of development of the plant - are a result of the combined effects of concentration of, and the time of exposure to, the toxin. Therefore, the SO_2 has to be detected in the following ways: selective measurement of SO_2 loading into the atmosphere; SO_2 loads in mg/m^3 air over longer time periods; and short time measurements of duration of SO_2 peak concentrations and their time of occurence. With these goals in mind, Herrmann (Institute for Forestry and Forest Protection, Faculty of Forestry at Tharandt, Technical University Dresden) succeeded in developing an SO_2 measuring device which he used during the year of 1962 for several measurements in various air pollution damaged areas of the GDR. The results of these measurements are presented.
Source: 6

#31
Lampadius, F. "The air-hygiene significance of the forest and its dependence upon harmful air pollution effects upon the forest." Angerwandte Meteorologie 4(8-10): 248-249 (November 1963).

In the author's opinion,the term 'filtering effect' which is generally applied to these processes of air purification has resulted not only in erroneous concepts of the purifying process, but sometimes also in its being overrated. Forest can be active, i. e., genuinely filter out pollutants, or "passive," i. e., create an obstacle to wind-borne pollutants. From research of others, author concludes that primarily large-grained smoke components are deposited on trees. Condition of forests is important. This can be affected by forestry activities.
Source: 8

#1002
Lampadius, F. "Die Bedeutung der SO2-Filterung des Waldes im Blickfeld der forstlichen Rauchschadentherapie." (Significance of SO2 removal by forests and smoke damage mitigation). Wiss. Z. Techn. Univers. Dresden (Herausgeber: Dresden), 17(2):503-511 (1968).

To test the expected SO2 filtration by forests, the pararosaniline method was used in a semi-continuous procedure. The goal was to find the extent of removal, and to clarify whether this is increased or decreased by different forest conditions. The tests were performed in large areas permanently affected by SO2. Measurements were taken horizontally and vertically in small, flat test areas. They show that SO2 removal by forests is negligible. However, this does not mean that forests are not significant and necessary to protect against SO2. They also mitigate against climatic influences that increase the impacts of SO2.
Source: 5,6

#1239
Lampadius, F. "Der Burkhardtswald bei Aue als Klassisches Beispiel Waldbaulicher Rauchschadenabwehr." (The Burkhardt Forest near Aue as a classical example of forestal smoke damage prevention). Abhandlungen der Saechsischen Akademie der Wissenschaften (Leipzig), Mathematisch-naturwissenschaftliche Klasse, 50(3):5-22 (1969).

The reduction or prevention of forestal smoke damage has two goals: To preserve forests as a vital part of civilization and to produce more lumber. This report documents the change of tree species in a smoke affected forest over a period of 70 to 80 years. Geography, climate, and geology of the forest area are described. A record of emissions and their effects on the forest is given. The performed changes are described and explained, and their costs are evaluated. The results of the measures are then analyzed, especially the production of lumber.
Source: 6

#1497
Lampadius, Felix. "Schaedigung des Waldes durch Waschmittelstaub." (Damage to forest by detergent dust (W-Dust)). Mitt. Forst. Bundesvers., 97: 451-471 (1972).

Forest fume damage has long been evident in the extensive forest region east of Genthin and is attributable to the pollution from three industrial concerns lying immediately to the west. In the context of regulations governing the compensation for and prevention of such damage, it is necessary to determine the importance of detergent dust as a phytotoxic substance. Apart from the sulfur dioxide pollution from the three neighboring sources, one of these sources, a detergent factory, also emits a considerable amount of detergent dust. Despite previous opinion to the contrary, the symptoms of damage in these regions and the general damage situation indicate that detergent dust is a cause of plant damage. The fume damage to conifer forests caused by SO_2 is different in terms of both symptoms and general nature. The

SO_2 and detergent dust pollution were determined for 1 year by analyses of the air close to the ground, and dusting tests were made on needles and leaves of various trees to determine the phytotoxicity of the dust. After it had been shown that the actual damage to these plant organs was due to the effects of the detergent dust dissolved in water, experiments were conducted in the laboratory and the field. They showed the sensitivity of the individual tree species to the injurious dust; this sensitivity varied as a function of environmental factors. The physiology of the damage process was explained by means of the CZAJA Mnium test.
Source: 1

#1235
Lampadius, F. and D. Bochmann. "Erfahrungen zur Abwehr von Chronischen Rauchschaedemit Waldbaulichen Mitteln im Westsaechsischen Huegelland." (Results of forestal measures to counteract smoke damage in West Saxony). Abhandlungen der Säechsischen Akademie der Wissenschaften (Leipzig), Mathematisch-naturwissenschaftliche Klasse, 49(4):5-19 (1967).

This report analyzes whether forestal measures performed in a small forest area during the last 60-70 years have succeeded. The forest area is described geographically, climatically, and geologically and the prevailing emissions are examined. Then, the four major steps of treatment are named. They are: forming of smoke barriers consisting of leaf trees; mingling of pine and spruce in various patterns; including larches to achieve a smoke resistant stock; and, lastly, the use of leaf trees in small areas.
Source: 6

#1237
Lampadius, F. and D. HäuBler. "Therapie gegen Rauchschäden durch Düngung." (The effects of fertilizing smoke damaged pines). Wiss. Z. Techn. Univers. Dresden (Herausgeber: Der Rektor), 11(6):1417-1424 (1962).

A 20 year old smoke affected pine stand was examined for effects of fertilizing on length, dry weight, and cross-section of the needles. It was checked whether the growth restricting influence of the smoke affected increase in length and width of needles c ected from fertilizing. The prevailing conditions of emission were measured. To determine the effects of the gases, Härtel's turgidity test was used. Relative to the fertilized and unfertilized pines, it was possible to find clear differences in length, weight, cross-section of the needles and in height and width. This work suggests that fertilizing is a treatment to counteract air pollution damage.
Source: 6

#1943

Lance, J.C. "Nitrogen removal by soil mechanisms." Journal WPCF, 44(7): 1352-1361 (1972).

Nitrogen may be removed from a soil system in gaseous form by volatilization of ammonia or by denitrification. The amount of ammonia volatilized in a land disposal system is small, but large amounts of nitrogen could be removed during travel through a long stream or channel to the disposal area. Denitrification is perhaps the most desirable removal process because large amounts of nitrogen can be removed and transferred to the atmosphere as N2. The nitrogen is thus completely removed from the system without causing air pollution. Additional research will be needed to determine whether denitrification can be sustained in a groundwater recharge system without prior oxidation of ammonium and/or additional sources of carbon. The removal of plant tissue from the land is the only other means of completely removing nitrogen from the system. This is an effective method which would be unsuitable for large urban areas because it requires large areas of land. It could be attractive for small towns and cities because of availability of cheap land and the economic return from the crop harvested. Large quantities of ammonium ion can be adsorbed by clays, but such immobilization is not permanent because it can be replaced by other cations or removed by nitrifying organisms. This mechanism can be important in concentrating most of the nitrogen into smaller volumes of water which could be treated again or used for its fertilizer value. Large quantities of nitrogen can be immobilized by soil organic matter, but a high-rate recharge system would be saturated with nitrogen within a few years. Some nitrogen can be immobilized in microbial cells and converted to soil organic matter as the microbes die. The natural chemical and biological processes occurring in soils offer tremendous potential for the reclamation of municipal wastewater without eutrophication hazards when a proper management system is developed and followed.
Source: 5

#1499

Landau, Emanuel. "The public control of air pollution: A case study in agriculture." American Univ., Washington, D.C., Thesis(Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 325 p. (June 1966).

Air pollution-induced agricultural damages in the USA are surveyed. Damages to crops and livestock are estimated currently at $500,000,000 at prices paid the farmer. However, the basis for these estimates are vague and ill-defined, existing only for selected areas of the USA and for damage to specific crops. Hence, the overall extrapolation is based upon limited data. Pollution by sulfur dioxide, in particular, constitutes at least 1/3 of the damage done to agriculture by air pollution. Air pollution-induced agricultural damages can be best estimated for small areas on the basis of objective yield surveys which currently are limited to corn, soybeans, and cotton. The first two crops are not substantially damaged according to our present knowledge of phytotoxicants. Statewide air pollution crop surveys as initiated by the University of California at Riverside are another means of assessing agricultural damages by air pollution. Control programs to reduce agricultural damage are mentioned.
Source: 1

#587
Langer, G. "Particle deposition and reentrainment from coniferous trees. Part II. Experiments with individual leaves." Kolloid Z. Z. Polym., 204:119-124 (1965).

The roles of bounce-off, deposit thickness, reentrainment, leaf position, interaction of leaves, and electrostatic forces were investigated. A streamlined-flow aerosol wind tunnel was used. After particles were removed from the aerosol by the object under study, the particular streamlines involved carry fewer particles. The aerosol then flows through a filter of uniform porosity, and the streamlines which are free of particles show as blank areas on the filter surrounded by areas of dust. In the deposition of dust on single leaves of coniferous trees, electrostatic effects were of no significance and did not improve adsorptions. Inertial deposition was the controlling parameter, in agreement with the filteration model for single cyclinders. The deficiencies of the cedar leaf at 1.30 m/sec for a 2.4 micron surface diameter dust was 6.0 and 0.5% for the edge and broad-blade positions respectively. Collection on the back of the wires or leaves due to wake turbulence did not take place. The scale of the turbulence was too small. Bounce-off upon deposition was not observed. Reentrainment did not take place up to the 10 m/sec velocity in the 1.8 cm diameter wind tunnel, where boundary layer conditions were much steadier as in the large tunnel. In arrays of leaves a shadowing effect was produced by the forward leaves.
Source: 1

#1500
Langkramer. Otakar. "Vliv prumyslovych exhalaci na mikrofloru pud smrkovych prorstu v Krusnych Horach." (Effect of industrial exhalations on the microflora of spruce growth soil in the Krusna Mountains). Imise a Le ni Cenoxy (Emissions and Forest Coenosis) (Prague), 53-62 (1968).

The effects of industrial emissions on the quantitative and qualitative composition of the soil microflora in spruce stands were studied. Four areas of spruce stands were examined: two were undamaged, one was moderately damaged, and one was heavily damaged by industrial emissions. The total number of aerobic, anaerobic, and sporulating bacteria, celulolytic microbes, and microscopic fungi were determined. The basal respiratory activity of the soil, ammoniation capacity, nitrification capacity, moisture, pH reaction, and the amount of organic carbon and total nitrogen in the soil were studied. The soils in the area most heavily affected has the lowest organic carbon and total nitrogen content, the lowest carbon dixoide production, the highest average number of aerobic, anaerobic, and sporulating bacteria, and the smallest number of celulolytic micro-organisms. Ammoniation was better in both damaged soils, and nitrification was weak in all the soil samples.
Source: 1

#1501
Lanphear, F. O. "Air pollution injury to plants in St. Louis." (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis. 14 p.) (June 14-18, 1970).

Preliminary observations of plants in the St. Louis area in the fall of 1968 resulted in identification of possible sulfur dioxide injury to sugar maple and probable ozone injury on lilac, black locust, and white pine. Also, Gingko exhibited injury suspected of being due to air pollution in various parts of the city, but most severe in conjunction with heavily travelled expressways. The symptoms on the Gingko were marginal necrosis progressing to necrosis of the entire leaf blade. Laboratory studies with ozone on Gingko demonstrated stippling at 70 pphm, but nothing similar to that observed in the field. Petunias, especially white varieties that are considered sensitive to peroxyacetylnitrate, were observed for possible PAN injury but this was not detected even though ozone damage to lilacs was detected in the area. Field observations were again conducted in the spring of 1969, and the primary pollution injury was typical of the photochemical pollutant ozone. Except for the evidence of herbicide damage early in the spring most injury appeared in June or July. Phenoxyacetic acid herbicides caused considerable damage over a 1-2 square mile area, with lesser damage more widespread. Chemicals involved in the production of these herbicides were screened and experimentally tested on forsythia. The value of plants as biological parameters was evident.
Source: 1

#990
Lanphear, F.O. "Urban vegetation: values & stresses." Hort. Sci., 6(4): 332-334 (1971).

Plants can exert a significant effect on reducing the stresses of the hostile urban environment. Though not a question of human survival, trees and shrubs contribute to the alleviation of noise, atmospheric dust and gas, as well as modifying climatic extremes of temperature and wind. The concept of greenbelts around urban centers and along expressways, as well as green open space needs further consideration in urban planning. At the same time, horticulturists must concern themselves with the problems of growing plants in urban environments with pollution, restricted space, and other stresses. Selection and breeding for woody plants adaptable to urban stress is absolutely needed. At the same time, we must encourage stricter control of environmental pollution or the time will come when neither plants nor people will survive in the city.
Source: 5

#1502
Lanphear, F.O. and Oscar H. Soule. "Injury to city plants from industrial emissions of herbicides." HortScience, 5(4):215-217 (Aug 1970).

Injury typical of the phenoxyacetic acid herbicides 2,4-D and 2,4,5-T was observed in a large area of St. Louis, Missouri, in the spring of 1969. Screening of chemicals from a local manufacturer of these herbicides first on Forsythia intermedia, and then on Ailanthus altissima and Cercis canadensis revealed that at least seven chemicals involved in the production of these herbicides produce symptoms similar to those observed in the field, namely the sodium salt of 2, 4-D, 2,4-D isobutyl, 2,4-D acid, 2,4-D isoctyl, 2,4-5-G iosbutyl, 2,4,5-Tisoctyl, and 2,4,5-T acid. The concentrations required for injury to occur varied between 10 ppm to 1 ppm, with the isobutyl ester of 2,4-D appearing most active. The field survey revealed Ailanthus and Ulmus as the most sensitive, and Acer saccharum and Syringa as the most tolerant species.
Source: 1

#212
Largent, E.J. The Effects of Air-Borne Fluorides on Livestock. Louis C. Mccabe (ed.). Interdepartmental Committee on Air Pollution, Washington, D.C., Air Pollut., Proc. U. S. Tech. Conf., Washington, D. C., p. 64-72 (May 3-5, 1950).

Fluorides carried through the air and deposited on pastures and fields of forage pose a hazard of chronic fluorosis to livestock fed on these plants. Previous reports on the mechanism and symptoms of flurosis occurring in livestock near factories are reviewed. An investigation is described in which cattle kept on a farm in the vicinity of a rock phosphate plant developed clinical fluorosis. The results of measurements of fluoride concentrations in the atmosphere over the farm, in samples of vegetation grown on the farm, and in the tissues of the exposed cattle are given. Fluoride levels in both air and vegetation decreased as the distance from the factory increased. Concentrations of fluoride in the bones of affected animals were abnormally high.
Source: 1

#1979
Larsen, R.I. and W.W. Heck. "An air quality data analysis system for interrelating effects, standards, and needed source reductions: Part 3, vegetable injury." J. Air Pollution Control Assoc., 26(4):325-333 (1976).

Acute leaf injury data are analyzed for 19 plant species exposed to ozone or sulfur dioxide. The data can be depicted by a new leaf injury mathematical model with two characteristics: (1) a constant percentage of leaf surface is injured by an air pollutant concentration that is inversely proportional to exposure duration raised to an exponent; (2) for a given exposure duration, the percent leaf injury as a function of pollutant concentration tends to fit a lognormal frequency distribution. Leaf injury as a function of laboratory exposure duration is modeled and compared with ambient air pollutant concentration measurements for various averaging times to deter-

mine which exposure durations are probably most important for setting ambient air quality standards to prevent or reduce visible leaf injury. The 8 hour average appears to be most important for most of the plants investigated for most sites, 1 hour concentrations are important for most plants at a few sites, and 3 hour SO_2 concentrations are important for some plants, expecially those exposed to isolated point sources of the pollutant. The 1, 3, and 8 hour threshold injury concentrations are listed for each of the 19 plant species studied. To prevent or reduce acute leaf injury, fixed, nonoverlapping ambient air quality measurements and standards are recommended for averaging times of 1, 3 and 8 hours.
Source: 5

#825
Laundon, J. R. "Urban lichen studies."In: Air Pollution and Lichens. B.W Ferry, M.S. Baddeley, and D.L. Hawksworth (eds.), Toronto Univ. Press, Toronto , Chapter 6, p. 109-123 (1973).

A review of urban lichen studies is presented. They are chiefly concerned with the impoverished lichen flora of towns and cities and the reasons for this poverty. Air pollution is generally blamed for this scarcity. Pollution was reported as early as 1273, but it did not become widespread until the middle of the 19th century. There is no recorded marked improvement in the lichen flora of any urban area to date because of the high levels of sulfur dioxide. The history of urban studies is categorized into early investigations, zonation, aridity, scales, modifying factors, and other investigations.
Source: 1

#588
Leben, C. and H.B. Kriebel. "Air pollution damages Ohio pines." Ohio Rep., 55:66-68 (Aug 1970).

A number of diseases affecting white pines are caused by air pollutants. A disease known as chlorotic dwarf is particularly troublesome because it is so evident and harmful to afflicted white pines. This disease is best observed in 10-15 year-old trees. In a polluted region, 5-30% of the trees of a single planting may be reduced in height, have stunted roots, and mottled needles. Air pollutants damage white pines by harming the needles, where nutrients are produced. The capacity for nutrient production is thus reduced, affecting needles during the growing season. The next spring, the plant begins the season with fewer reserve nutrients, which results in dwarfing. The chlorotic dwarf condition is an advanced stage of air pollution damage. It occurs when sensitive trees are exposed to pollutants year after year. The three main gaseous pollutants affecting plants are sulfur dioxide, ozone, and peroxyacyl nitrate. The best long-term control method would be to plant white pines known to be genetically resistant to damage by air pollutants. The discovery that some white pines are sensitive to air pollutants has resulted in the realization that levels of polluted air that may be harmful to plants are much more widespread than previously suspected.
Source: 1

#1098
Lebenidze, G. "Which trees purify air?" Current Digest of the Soviet Press, 23(5):26 (March 2, 1971).

Research on the relationship between plants and hydrocarbons, which has recently acquired particular urgency because of the increasing pollution of the atmosphere is being conducted by the Georgian Republic Academy of Sciences' Laboratory of Plant Biochemistry. Studies on more than 100 varieties of plants reveal that there are many plants that absorb and assimilate benzene at a high rate. The common maple, the Russian olive, the wild Caucasian pear, and the Canadian poplar have been shown to be particularly good sanitation workers. N. N. Ketskhoveli, director of the Botany Institute, suggests that the planting of trees and shrubs in cities should be on a more scientific basis in order to select trees that reduce pollution in the atmosphere instead of selecting trees that grow quickly.
Source: 6

#1505
LeBlanc, Fabius. "Influence de l'atmosphere polluee des grandes agglomerations urbaines sur les epiphytes celticoles." (The influence of polluted air in large urban agglomerations on the corticoline epiphytes). Rev. Can. Biol., 20(4):823-827 (1961).

The phytosociology of corticoline epiphytes in the Montreal area, Canada, was studied. Although corticoline epiphytes are particularly abundant in Southern Quebec, and especially in the mountainous region, the trees investigated in the center of Montreal were completely free of epiphytes. Within a radius of 15 to 18 miles around Montreal, these plants reappeared though they had reduced vitality. It was only outside the radius that societies of corticoline epiphytes became abundant and well developed. The absence of corticoline epiphytes in the center of Montreal, and the scarcity of such species around Montreal is most possibly due to the presence in the air of air pollutants, especially sulfur dioxide, which are toxic for these corticoline lichens, rather than to the extreme dryness of the air.
Source: 1

#1503
LeBlanc, F. "Epiphytes and air pollution." Council of Europe Committee of Experts on Air Pollution, Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 211-221 (April 22-27, 1968).

The sensitivity of epiphytes to atmospheric pollutants was investigated in three areas: Wawa, Ontario, where an iron sintering plant is located, Sudbury, Ontario, where three nickel smelters are located, and Montreal. In Wawa and Sudbury, thenumber of epiphytes as well as their coverage (percentages) was inversely proportional to the degree of pollution by sulfur dioxide. In the vicinity of the iron sintering plant, there is a large epiphyte desert, a high atmospheric SO_2 concentration, and a significant

increase in the acidity and sulfate conentration in surface waters, soils, and plant materials. Within a 10 km radius of the nickel smelters, no epiphytes occur because all trees have been destroyed. Beyond this area trees exist but are widely dispersed. In Montreal, a direct relationship exists between the quality of epiphytic vegetation and the location of heavy industries and residential centers. The percentage of frequency of epiphytes increase with distance from the city. The absence of highly toxiphobus epiphytic species may have use as an indicator of SO_2 pollution.
Source: 1

#826

LeBlanc, F., and J. DeSloover. "Relation between industrialization and the distribution and growth of epiphytic lichens and mosses in Montreal." Can. J. Botany, 48(8):1485-1496 (August 1970).

Although there exist no direct experimental proofs that the contaminated atmosphere of Montreal has exerted some influence on the present composition of the lichen and moss vegetation of this area, field studies were conducted which show that this vegetation has completely disappeared from the nuclei of human implantations and that its presence, degree of abundance, and luxuriance in the peripheral parts appear, on the whole, directly related to its remoteness from industrial or residential zones. A simple method of mapping the long-range effect of air pollution on corticolous epiphytes is described. The map does not, however, produce any information on actual, or day by day, concentrations of phytotoxicants nor is it of any value in predicting pollution episodes.
Source: 1

#589

LeBlanc, F., and D. N. Rao. "Effects of sulphur dioxide on lichen and moss transplants." Ecology, 54(3):612-617 (Late spring 1973).

Injury in lichen and moss transplants were correlated with sulfur dioxide concentrations in the Sudbury area during 1970. Bark-discs bearing lichens and mosses were cut from an unpolluted region nearly 40 km east of Sudbury. The discs were photographed, and the epiphytes on them were inventoried. These were arranged in groups of six in cut-out holes on wooden boards. Two boards were fixed at 8-10 m on a tall, exposed tree at each of 19 selected sites in the five SO_2 polluted zones delineated for the area. After 1 yr., changes in epiphytes, especially in Parmelia sulcata, taking place in the different pollution zones were compared with respect to external and internal morphology, biomass, acidity, total sulfur, and chlorophyll. Different SO_2 concentrations produced different sets of harmful effects which were more or less directly related to the pollution levels. While the trend has been to relate floristic and/or phytosociological characteristics of lichens and mosses to SO_2 concentrations, the present study sought a quantitative correlation between levels of injuries and levels of SO_2.
Source: 1

#1953

LeBlanc, F., and D.N. Rao. "Evaluation of the pollution and drought hypotheses in relation to lichens and bryophytes in urban environments." Bryologist, 76(1):1-19 (Spring 1973).

The evidences on the pollution and drought hypotheses which seek to explain the rarity of lichens and bryophytes in urban environments are critically examined. The premise and logic of the drought hypotheses are not acceptable. The importance of experimentation and of phytosociological quantification in ecological hypotheses are stressed.
Source: 1

#1504

LeBlanc, F., D.N. Rao, an G. Comeau. "Indices of atmospheric purity and fluoride pollution pattern in Arvida, Quebec." Can. J. Botany, 50(5): 991-998 (1972).

Indices of atmospheric purity (LAP) of 42 sites located in all directions from the aluminum factory at Arvida and spread out to about 250 sq km area, were determined on the basis of phytosociology of epiphytes of Populus balsamifera. These index values ranging from 0 to 103 were arranged into six groups and the investigated area was accordingly delineated into six LAP zones to represent areas with different levels of chloride pollution. A relative picture of the approximate limits of F contamination in different zones is obtained by the F accumulation in Parmelia sulcata thalli transplanted at various sites in the area.
Source: 1

#1506

LeBlanc, F., D.N. Rao, and G. Comeau. "The epiphytic vegetation of Populus balsamifera and its significance as an air pollution indicator in Sudbury, Ontario." Can. J. Botany, 50:519-528 (1972).

Indices of atmosheric purity (IAP) of 31 sites selected in sulfur dioxide-polluted as well as in non-polluted areas around Sudbury, Ontario were determined in the basis of number, frequency-coverage, and resistance factor of the epiphytes of Populus balsamifera. The investigated area was delimited into 5 different IAP zones based on these indices, arranged into convenient ranges. The zones were then compared with SO_2 pollution zones based on ground-level average concentration of the gas prevailing in the area, and the comparison indicated that the biological method provides a valid, quick, and economical method for assessing and mapping the long-range effect of pollution for a given area.
Source: 1

#590
Lee, J. A. "Lead pollution from a factory manufacturing anti-knock compounds." Nature, 238(5360):165-166 (July 21, 1972).

In a study of the edaphic factors affecting certain grassland communities in Cheshire, significant lead levels were found in vegetation in the vicinity of a factory manufacturing anti-knock compounds which consist of tetraethyl and tetramethyl lead. Moss species found in abundance at the sample sites were collected and their mean lead content was taken as a measure of the lead accumulated in the ground layer. At sites where three or more species were sampled there was fairly good correspondence in the lead content of the species. Samples of Holcus lanatus were also taken. There was a rapid decline in the lead concentration in the vegetation away from the factory in the first 400 m and a slower decline in the next 400 m. At 800 m, however, the amount of lead in the mosses was between two and three times that in the same species collected in rural area far from any industry. Concentrations as great as 286 ppm were observed in a pasture downwind of the factory; this was nearly three times as much as in roadside samples from central Manchester. A sample of Holcus lanatus from immediately outside the factory had a lead content of 1838 ppm. Some of the contents recorded in Holcus lanatus are likely to be highly toxic to herbivores.
Source: 1

#1507
Lee, J. A., and J. H. Tallis. "Regional and historical aspects of lead pollution in Britain." Nature (London), 245(5422):216-218 (September 28, 1973).

Two major periods of increase in atmospheric lead concentrations have been recognized in the Northern Hemisphere; the first resulting from the rapid growth of industry during the two previous centuries; and the second resulting from the expansion of motor vehicle traffic since the end of the Second World War. Historical trends in lead pollution in Britain were examined by use of nineteenth century and present day moss specimens and by peat profiles. The moss specimens showed clear regional differences in lead concentrations, the lowest concentrations being recorded for samples from the oceanic areas remote from large population centers, and the highest being for samples from the old lead mining and smelting areas of Teesdale and the White Peak of Derbyshire. In none of the regions studied was there any significant increase in the lead content of the present day samples. A peat profile from Snake Pass in Derbyshire showed major lead pollution which correlated well with the industrialization of the surrounding area and the rise of the Derbyshire lead industry. A Buxton, Derbyshire peat profile showed a similar increase in lead pollution paralleling the growth of the lead industry in that region. Samples from northern Scotland, a region of low background pollution, showed that the exhaust from motor vehicles had had little effect on the lead concentrations in vegetation away from busy roads. Thus, the overall regional pattern of lead pollution has been little affected by automobiles.
Source: 1

#1508
Lee, T.T. "Chemical regulation of ozone susceptibility in Nicotiana tabacum." Can. J. Botany, 44:487-496 (1966).

Detached leaves of Nicotiana tabacum (variety White Gold), treated with urea, potassium nitrate, kinetin, or p-hydroxbenzoic acid became more susceptible to ozone injury. The chemically induced susceptibility was reversed by a subsequent treatment with sucrose and, to a less extent, with 3, 4-dihydroxbenzoic acid or L-cysteine, and the degree of reversibility was proportional to the duration and concentration of the respective treatment. Chemical modification of ozone susceptibility was effective on leaves at different stages of maturity. In the urea-treated leaves, the level of cytoplasmic non-protein nitrogen was positively correlated with the severity of ozone injury (correlation coefficient (r) equals 0.617). Positive correlations between leaf sensitivity and both total soluble nitrogen (r equals 0.718) and ammonia nitrogen (r equals 0.458) were also significant. A sucrose treatment after urea treatment effectively reduced the soluble-nitrogen fractions.
Source: 1

#1509
Lee, T., and D. H. Vitt. "A preliminary study of the effects of air pollution on lichen and bryophyte vegetation near Edmonton, Alberta." Environment Canada, Edmonton (Alberta), Canadian Forestry Service and Northeren Forest Research Centre, and Alberta environment. Research Secretariat, Proc. Workshop Sulphur Gas Res. Alberta, Edmonton, Alberta, p. 129-141 (Nov. 1-2, 1973).

Epiphytes such as lichens and mosses are responsive to pollutants such as sulfur dioxide, and can be used to monitor these pollutants. The ability of epiphytes to measure pollution was studied in Edmonton, Alberta, Canada. Lichens and mosses were sampled on aspen and balsam poplars. The frequency of occurrence was then determined for each species. An Index of Atmospheric Purity was then computed. In the Fort Saskatchewan area, there were eight species of epiphytes, in Refinery Row there were 17. In rural areas there were 24 species. Most lichens had low mean frequencies in the Fort Saskatchewan area that increased in the Refinery Row area and were highest in rural sites. Mosses, while almost absent from the Fort Saskatchewan area, did not increase significantly on rural sites over their frequencies near Refinery Row. The Index of Atmospheric Purity was lowest for the Fort Saskatchewan area (11), highest for the rural areas (38.6), and close to the rural area values in the vicinity of Refinery Row (35.7). The two sites at Refinery Row were 12% lower than the rural area, while the two sites near Refinery Row were 3% lower. Mean total cover values closely paralleled the Index of Atmospheric Purity values lowest for Fort Saskatchewan (8.9) and highest for rural areas (29.1), although Refinery Row values were close (28.7) and (25.9).
Source: 1

#1510
Legge, A.H. "Design of a gas exchange system for the study of the effects of sulphur dioxide on vegetation." Environment Canada, Edmonton (Alberta), Canadian Forestry Service and Northern Forest Research Centre and Alberta Environment, Research Secretariat, Proc. Workshop Sulphur Gas Res., Alberta, Edmonton, Alberta, p. 115-120 (Nov. 1-2, 1973).

A gas exchange system was developed for the intimate analysis of the effects of sulfur dioxide on vegetation in the Whitecourt area of the sour-gas corridor in the province of Alberta. Research is underway on 1-year-old seedlings of white spruce, moss, and lodgepole pine to determine quantitatively the effects of varying concentrations of sulfur dioxide under differing environmental conditions. Plant physiology is being correlated with the onset of visible plant symptom development with air quality. The gas exchange system was designed to continuously record processes of photosynthesis, respiration, and transportation in plants. The rate of carbon dioxide uptake determines primary production in green plants. The heart of the system is double linked growth chambers in which the plants are exposed to SO_2 and gas exchange is measured. The exposure chamber and measurement instrumentation are described.
Source: 1

#1511
Legouet, F., J. Delmas, and A. Grauby. "Methode experimentale d etude des effets de la pollution atmospherique sur les cultures." (Experimental method for the study of the effects of air pollutants on plants). Text in French. Bull. Inform. Sci. Tech. Commis. Energ. At. (Fr.), 191:75-80 (April 1974).

An experimental setup for the study of the individual and synergistic effects of sulfur dioxide, nitric oxide, nitrogen dioxide, carbon monoxide, and carbon dioxide on plants is described. Different plant species were exposed to controlled pollutant concentrations: 100 to 1000 micrograms/cu m in the case of SO_2 in a closed system of bells with controlled temperature, humidity, and light conditions. The rate of photosynthesis as a criterion of the effects of the air pollutants was measured.
Source: 1

#213
Leh, H. O. "Verunreinigungen von kulturpflanzen mit blei von kraftfahrzeugabgasen." [Contamination of cultured plants by lead from automobile exhausts]. Gesunde Pflanz., 18(2):21-24 (Feb. 1966).

Gasolines contain as antiknock additives of tetraethyl lead (0.02-0.06% by volume), equivalent to 200 to 600 milligrams of lead/l of gasoline, of which 50 to 70% are discharged into the air with the exhaust gases. Approximately 40 to 60 grams of lead km/hr would be emitted on an average highway. In 1964 the contamination of grass growing alongside of highways was tested. At a distance of one to two meters 53 to 95 micrograms of lead/g of dry substance (53-95 ppm) occurred; at five meters, 32-36 ppm occurred; at 100 m, 10 ppm was found. Potato leaves had an average lead content of 53

ppm at five meters and 37 ppm at 10 m distance. Beet leaves contained 29 ppm lead at five meters. These results were obtained with unwashed plants. The analysis of washed samples showed that most of the lead can be washed off, proving that the contamination takes place primarily on the surface. Generally, the effect of the polluted air on the plants was noticeable at up to about 100 m distance from the highway. The lead content of the roots and plant components below the ground surface, such as potatoes, beets, and carrots was relatively low, even at high lead concentrations on the leaves. Tests conducted with grain growing at two meters from the highway revealed about five ppm lead content. A special commission of the European Common Market countries has recommended for fodder plants a maximum permissable lead content of 10 ppm in the dry substance.
Source: 1

#1512
Leh, H. O. "Verunreinigung von pflanzen durch Blei aus Kraftfahzeugabgasen." [Pollution of plants by lead from automobile exhaust gases]. In: Blei und Umwelt. Kommission fuer Umweltgefahren des Bundesgesundheitsamtes, West Germany. 11 p. (1972).

Leaded gasolines have led to extensive lead pollution of the environment. The exhaust gases of 1000 cars emit 30 g Ph/km based on a gasoline consumption of 10 l/100 km, a Pb concentration in the gasoline of 0.4 g/l of which 75% are in the exhaust gases. In Switzerland, 700 tons of lead were emitted into the atmosphere with the exhaust gas in 1968, in the Netherlands 800 tons. In the Northern Hemisphere, the Pb emissions reach more than 500,000 t/yr. In the vicinity of busy streets and highways, the vegetation is considerably polluted by lead. The influence of traffic is clearly discernible to a distance of about 100 m on both sides of the highway. The extent of lead contamination is determined from the traffic density, the closeness to the highway, the exposure time, the surface structure of the leaves, the position of the leaves (vertical, horizontal), the quantity and distribution of precipitation, the wind direction, and wind strength. Above ground parts of the plants are more contaminated than underground parts. Part of the above-ground lead on plants can be washed off. The lead intake of humans is estimated to amount to 1.2 to 2.2 mg/day.
Source: 1

#591
Leonard, C.D. and H.B. Graves, Jr. "Some effects of air-borne fluorine on growth and yield of six citrus varieties." Proc. Florida State Hort. Soc., 83:34-41 (1970).

Young Hamlin, Pineapple, and Valencia orange, Orlando tangelo, Dancy tangerine, and March grapefruit trees were grown for 28 months in fine sand in 76 by 29 ft pots at six locations, five of which were exposed to different levels of airborne gaseous fluorine compounds. Variable but significant reductions in yield of the six citrus varieties occurred when the spring flush leaves sampled in May 1969 contained from 20-40 ppm fluorine. These leaf fluorine contents resulted from exposure for 11 weeks to air averaging 0.23 to 0.38 ppm fluorine. In most cases, the spring flush leaves sampled in October contained two and a half times as much fluorine as those sampled in

May. This increase in leaf fluorine was closely related to the mean fluorine content of air from May to October and to the additional exposure time. There were also highly significant yield reductions from dilute hydrofluoric acid (HF) applied to bearing orange trees only during the spring blooming season. This fact and the negative correlation between fluorine content of spring flush leaves sampled in May and yield strongly suggest that most of the fluorine-induced injury occurs in the spring bloom period. However very high levels of leaf fluorine accompanied by severe chlorosis can reduce yields the next year even in the absence of fluorine exposure during the period of bloom and fruit set. Only Valencia orange showed a significant reduction in growth.
Source: 1

#592
Leonard, C. D. and H. B. Graves, Jr. "Effect of fluoride air pollution on Florida citrus." Fluoride, 5(3): 145-163 (July, 1972).

The effect of different concentrations of fluorides in the leaves on the yield and quality of Valencia and Hamlin oranges and Marsh seedless grapefruit was studied. Under Florida conditions, exposure of citrus trees to relatively high levels of airborne fluorides during spring bloom period is believed to cause the greatest losses in fruit production. This in indicated by the significant reduction in yield of Hamlin oranges by each of three different concentrations of hydrogen fluoride sprays applied only three different times during the 1967 bloom period. Where the concentration of airborne fluorides is high enough during the bloom period to cause extensive leaf chlorosis, leaf burn, dropping of young leaves, and excessive dropping of bloom and small fruit, the mechanism causing yield reduction is obvious. Heavy drop of young leaves, bloom, and small fruit as a result of exposure in high levels of airborne fluorides, however, has occurred in relatively few Florida citrus groves. These symptoms of acute or severe fluoride toxicity did not occur on the trees in greenhouse experiments. In spray experiments, leaf burn and dropping of young leaves occured only moderately when the highest concentration of HF sprays was applied while the trees has an extensive new flush of immature leaves. No dropping of young leaves nor excess dropping of bloom and small fruit occurred during during the bloom period in the first three years of the spray experiments. Decrease in photosynthetic activity due to smaller leaf size and inhibition of chlorophyll synthesis probably accounts for much of the decrease in yield. The addition of urea to high managanese sprays for regreening of fluoride-chlorotic leaves appears to increase the absorption of Mn by the leaves over similar high Mn sprays with urea.
Source: 1

#214

Leone, I. A., E. Brennan, and R. H. Daines. "Atmospheric fluoride: its uptake and distribution in tomato and corn plants." Plant Physiol., 31(5):329-333 (1956).

Soil grown tomato and corn plants were subjected to hydrogen fluoride administered at various time-concentration levels designated as long-low, intermediate, and short-high fumigations, with the purpose of tracing the fate of the fluoride accumulated within the plants. Injury appeared more severe when the fluoride gas was administered in a short-high concentration dosage than when this same amount of gas was administered over a more protracted period. Corn was the more sensitive of the two species. As the fumigation level was increased, there was an increased fluoride accumulation. Tomato has a fluoride accumulating capacity approximately twice that of corn under all circumstances. Mature leaves accumulated greater quantities of fluoride than did younger leaves as a result of the more protracted fumigations. At the shorter higher level fumigations, the ratio of fluoride in mature to that in young corn leaves decreased to a certain point and then leveled off, whereas in tomato the ratio continued to decrease as fluoride concentration was increased. Washing the foliage removed even more fluoride than did natural diffusion.
Source: 1

#1514

Lerche, H. and S.-W. Breckle. "Blei im -Oekosystem Autobahnrand." (Lead in the ecosystem bordering highways). Naturwissenschaften (Berlin), 61(5):218 (1974).

Examination of native trees along highways has revealed a strong gradient of lead concentration depending on proximity to the street and traffic density. The various species of trees displayed different retention capacities for lead. In Carpinus butulus the lead concentration of the leaves dropped 1/4 at a distance 150 m from the highway, and Picea after 50 m. Lead retention was influenced by leaf morphology and the weather conditions. Of the retained lead 50 to 80% can be washed off by water. At 5 m from the highway Carpinus butulus measured 595 ppm Pb, Quercus robur 320 ppm, and Picea abies 91 ppm.
Source: 1

#1515

Lesley, J.W. and O. Clifton Taylor. "Temperature and air pollution effects on early fruit production of F1 tomato hybrids." Calif. Agr., 27(7):13-14 (Feb. 1973).

Atmospheric pollution may have been to blame for a decline in early fruit setting of tomatoes at Riverside, California. From June 12, 1971 to August 31, 1971, the level of total oxidants in the air was sufficient to injure susceptible plants. Accelerated senescence of the foliage and sunburn of the fruit, symptoms of oxidant injury, occurred. Hybrids formed by crossing VF6, VF36, and VFN8 varieties with an inbred line were in general superior to their parent varieties in early fruit production. It seems probable, though not certain due to the lack of controls, that the fruit yield was affected by very high air pollution oxidant levels early in the flowering season.
Source: 1

#215
Levi, E. "Distribution du cesium ou d strontium, absorbes simultanement par voies racinaire et foliaire, dans une jeune plante de haricot (Phaseolus vulgaris var, Berna), manifestee par la repartition de deux de leurs isotopes radioactifs." [The distribution of cesium and of strontium absorbed simultaneously through the roots and leaves of a young bean plant (Phaseolus vulgaris var, Berna), as manifested by the distribution of two of their radioactive isotopes]. C. R. Acad. Sci. (Paris), 271:311-313 (July 20, 1970).

Sr-85 was applied to leaves of young bean plants which simultaneously received Sr-89 through their roots. Other bean plants received Cs-134 through their leaves and Cs-137 through their roots. Following absorption, the distribution of the four isotopes in the plants was determined from their respective emissions and checked autoradiographically. While the absorption of Sr by a leaf of the plant was not followed by any basipetal movement, that of Cs resulted in its distribution all through the plant. The absorption of both elements through plant roots was followed by a rapid acropetal movement towards the leaves. The specific transports were not influenced by simultaneous absorption through roots and leaves and thus confirmed the independence of the Phloem and xylem in young bean plants.
Source: 1

#1013
Levitt, J. (ed.). "Miscellaneous stresses." In: Responses of Plants to Environmental Stresses, Academic Press, Chapt. 20:531-543 (1972).

Various environmental stresses to plants are examined, including such man-made ones as sulfur dioxide, photochemical or oxidant smog involving ozone and peroxyacetyl nitrate, ammonia, and nongaseous chemicals such as herbicides. Such agents can induce both primary and secondary stresses, and the strains produced may be elastic (reversible, e.g. growth inhibition) or plastic (irreversible). Resistance may be due to avoidance (e.g. very waxy leaves prevent penetration of some substances) or to tolerance (e.g. by metabolizing the substances in the cell). Any environmental condition that favors stomatal opening increases the absorption of SO_2 ; while, on the other hand, 1 ppm of SO_2 may itself increase the degree of stomatal opening throughout the day and night. The actions of ozone and peroxyacetyl nitrate are of the oxidizing type, while that of SO_2 is reducing. The former two injure the lower surface of the leaf, while SO_2 injures the upper. Although PAN injury is increased by high light intensity and greatly decreased by darkness, its absorption is unaffected by the opening and closing of stomata. Acid plants are NH_3 resistant due to neutralization of the NH_3 by their large reserve of organic (N-free) acids stored in the vacuole; whereas amide plants are not resistant due to the absence of this avoidance mechanism. The great majority of plants are of the amide kind and therefore are not NH_3 resistant.
Source: 1

#1433

Levy, E. A. "The biosphere as a possible sink for carbon monoxide emitted to the atmosphere. Final report." Stanford Research Inst., Irvine, Calif. SRI Project PSU-7888, 31 p. (May 1970).

The capacity of various elements of the biosphere to remove carbon monoxide from the atmosphere was investigated by exposing test samples to 100 ppm CO in environmental chambers under static experimental conditions. Analysis was by gas chromatography. Results showed that non-sterile soil depleted CO rapidly from test atmospheres containing initial concentrations of 100 ppm CO. This effect was enhanced by increasing temperatures and eliminated by steam sterilization, indicating that heat-labile biological mechanisms were involved. The minimal experimental depletion rates demonstrated theoretically could account for 2.06 times 10 to the 15th power grams CO annually on a worldwide basis. Moistened vermiculite exposed to ambient air for several weeks depleted CO from test atmospheres containing 100 ppm CO. Sterilization eliminated this effect. CO decreased in the atmosphere above plant of pepper, geranium, and barley growing in nonsterile support medium (soil, vermiculite). However, the role of higher plants as a possible CO sink could not be adequately assessed because the plant effects, if any, were masked by those of the support media. The effect of marine plants on CO disappearance indicated a trend toward marine plant utilization of CO at temperature of 19.5 C but not at 10 C. Thus, the findings suggest that the microorganisms in the biosphere can serve as a CO sink, although further study is necessary.
Source: 1

#92

Lewis, J. A., and G. C. Papvizas. "Effect of sulfur-containing volatile compounds and vapors from cabbage decomposition on Aphanomyces euteiches." Phytopathology 61:208-213 (1972).

Vapors from several sulfur-containing compounds adversely affected various processes in the life cycle of Aphanomyces euteiches. Isothiocyanate vapors were more effective than those of sulfides in inhibiting growth, zoospore formation, motility, and zoospore germination. For example, mycelial growth and zoospore formation and germination were prevented by vapors of 0.04, 0.10, and 0.30 parts per million (ppm) of allylisothiocyanate (AIT), respectively, and the same processes were prevented by vapors from 20, 100, and 350 ppm of $(CH_3)_2S_2$. Sublethal amounts of the volatiles had no effect on oospore formation. Pea root rot was reduced by more than 90% when soils were fumigated from CS_2, $(CH_3)_2S_2$, AIT, methylisothiocyanate (MIT), or CH_3SH. Materials not as effective in disease reduction included butylisothiocyanate (BIT), phenethylisothiocyanate (PhIT), and $(CH_3)_2S$. Vapors from the decomposition of cabbage tissue, an amendment which suppressed disease, adversely affected morphology of the fungus, development of oospores, and mycelial growth. Vapors arising from the decomposition of corn tissue, an amendment which did not suppress disease, had no effect on the fungus.
Source: 7

#1516
Liang, T. "Semi-annual status report of the remote sensing program. Appendix D. Plant sensitivity to atmospheric pollution." Cornell Univ., Ithaca, N. Y., Remote Sensing Program, National Aeronautics and Space Administration Grant NGL 33-010-171, 33 p. (Dec. 27, 1973).

The relative sensitivity of various forms of vegetation to ozone, sulfur dioxide, hydrogen fluoride, nitrogen oxides, peroxyacetyl nitrate, ethylene, 2, 4-dichlorophenoxyacetic acid, chlorine, hydrogen chloride, mercury ammonia, and hydrogen sulfide was compiled. Sensitivity data were incomplete in certain cases, different sensitivity ratings were encountered and are listed.
Source: 1

#593
Liebenow, H. "Die Bedeutung der Immissionen fuer Pflanzen und Tierbestaende." (Bearings of emissions on plants and livestock). Monatsh. Veterinaermed., 26(3): 106-111 (Feb. 1, 1971).

Plant and livestock damage from sulfur dioxide, fluorine and its compounds, ozone, and dusts is discussed. The threshold sensitivity limits for plants are 0.3 mg/cu m SO2, 0.01-0.03 mg/cu m fluorine, and 0.2 mg/cu m ozone in ambient air. Pine and fir are among the most sensitive tree species and the sugar beet appears to be the most susceptible plant to these pollutants. Macroscopic damage to plant species from SO2 includes reddish brown color of the comiferous needles and brown spots on the leaves; chlorophyllous alterations and damage of cytoplasmic organelles appear on the microscopic level. A concentration of 0.15 mg/cu m SO2 reduces the daily milk performance in cattle by 9% and the milk fat content by 8%. Aluminum and superphosphate plants are the main sources of fluorine pollutants. Fluorine and its compounds cause the blackening of needle and foliage tips and chloroplast decay in plants. Dental fluorosis is the most common fluorine-induced disease in livestock. Fluorine produces impairment of calcium and phosphorus metabolism as well as alterations in cellulose digestion processes. The bean species appears to be the most sensitive plant to ozone. Ozone causes death from lung edema in livestock and the incidence of lung and skin cancer appears to be twice as high in ozone-polluted areas than in unpolluted air. Arsenic-bearing dusts produce the most damaging effects on livestock following ingestion of dusty feed, and accumulation of dusty layers on plant surfaces hinders normal metabolism.
Source: 1

#1143
Lieth, H. "The role of vegetation in the carbon dioxide content of the atmosphere." J. Geophys. Res., 68(13):3887-3898 (1963).

The interchange of CO_2 between vegetation and the atmosphere is discussed. Some basic physiological properties of plants are reviewed with respect to the gaseous exchange. The behavior of the plants within their environment is then explained, since the normal CO_2 exchange of the vegetation occurs under ecological conditions. Some data of various authors are presented which show how effectively a vegetation unit can change the CO_2 content of the atmosphere near the ground. The productivity concept for the whole biosphere is explained in detail because it enables us to calculate the CO_2 exchange between biosphere, atmosphere, and geosphere. On the basis of this concept two calculations are given, for forests in Europe and Malaya, of the quantity and the time of the turnover. The cycle of carbon through the biosphere, atmosphere, and geosphere or hydrosphere is discussed from various points of view. The distribution of carbon over the surface of the earth is listed according to compilations of various authors.
Source: 5

1179
Lihnell, D. "Sulphate contents of tree leaves as an indicator of SO_2 air pollution in industrial areas." National Inst. for Plant Protection. Solnof, Sweden. pp. 341-352. (No date)

Sulphate was estimated in leaf samples (mainly from birch) by turbidometrical measurement of the density of precipitated barium sulphate to map SO_2 pollution around SO_2 emitting industries in Sweden. Diagrams based on 'sulphate values' obtained in one of the areas indicate the pollution at different distances from its source, its connection with wind condition, variation from year to year, the influence of changes in the industrial activity and the interaction between several associated sources of pollution.

Analysis of birch and apple leaves, and spruce needles on the whole gave results in accord. The sulphate diagrams from birch leaves and the diagrams on growth reduction in confiers are similar in form. Altogether the results support the assumption that, at least under certain conditions, sulphate analysis in tree leaves gives a reliable picture of SO_2 pollution.
Source: 6

#595
Lind, C.J., and P.W. Wilson. "Mechanism of biological nitrogen fixation. VIII carbon monoxide as an inhibitor for nitrogen fixation by red clover." J. Am. Chem. Soc., 63:3511-3514 (Dec. 1941).

Evidence from experiments in which total nitrogen fixed was estimated, as well as others in which rate of fixation was measured, shows that uptake of free nitrogen by inoculated red clover plants is inhibited by as little as 0.01% carbon monoxide. The fixation process is practically stopped by 0.05% CO. In this range of pCO, no effect on assimilation of ammonium nitrate by uninoculated plants is observed, but at higher concentrations definite inhibition is detectable. The inhibition of nitrogen fixation appears to be reversible and non-competitive.
Source: 1

#594

Lind, C.J. and P.W. Wilson. "Carbon monoxide inhibition of nitrogen fixation by Azotobacter." Arch. Biochem., 1:59-72 (1942-1943).

Carbon monoxide inhibition of nitrogen fixation by Azotobacter vinelandii was established in macro total nitrogen experiments. Definite inhibition was observed when the CO concentration was 0.1-0.2%; it increased with the pCO until 0.5-0.6% when fixation was almost completely suppressed. This inhibition is comparable with that of innoculated red clover plants, but the quantity of CO required is about 10 times greater than for the symbiotic system. In the range of CO concentration inhibitory for nitrogen fixation by Azotobacter little consistent effect is noted on the assimilation of combined nitrogen, thereby establishing the specificity of the inhibition for nitrogen fixation. Azotobacter cultures kept on a nitrogen free medium in air required a period of adaptation before they readily use nitrate (or nitrite) and probably asparagine. With the adapted cultures, the rate of assimilation of nitrogen sources appears to be highest, urea and ammonium; somewhat less, molecular nitrogen,, nitrate, nitrite, and asparagine; much lower, aspartate and glutamate.
Source: 1

#976

Linnenborn, V. J., J. W. Swinnerton, and R. A. Lamontagne. "The ocean as a source for atmospheric carbon monoxide." J. Geophys. Res., 78(24):5333-5340 (1973).

Data obtained over the past three years on the amount of CO in the waters of the northern hemisphere provide a basis for estimating the contribution of the oceans to the atmospheric CO budget. Estimates of the ocean's contribution to the northern hemisphere CO budget approach the concentration of anthropogenic CO production, which is approximately 2×10^{14} grams CO per year. The gas exchange equation is used to calculate a transfer coefficient for CO in seawater. The equation is $Q = E(p_w - p_a)$, where Q is the flux of gas, E is the gas transfer coefficient, and p_w and p_a are the partial pressures of the gases in water and air, respectively. E is calculated by measuring the flux of CO, which is related to the difference between the day and night vertical concentration profiles. As a first approximation, an upper limit on the amount contributed by the oceans during a 24 hour period can be estimated. E is calculated by the above method using 14 vertical profiles obtained over a 3-year period from widely separated locations. A value for E of 41×10^{-3} mg cm^{-2} min^{-1} is obtained. An average calculated CO flux for the northern hemisphere is 9×10^{13} grams per year, or approximately 34% of man's input. Release of CO from the southern oceans in amounts comparable to those found in the northern oceans would increase the contribution of the world ocean to the global CO budget to a level approximately 85% of that due to man.
Source: 5

#216

Linzon, S.N. "Sulphur dioxide injury to trees in the vicinity of petroleum refineries." Forestry Chronicle, 245-50 (June 1965).

Damaging concentrations of atmospheric sulphur dioxide have, under favorable environmental conditions, caused severe injury to susceptible trees growing in the vicinity of petroleum refineries located at Clarkson, Ontario and East St. Paul, Manitoba, The damage is described and the factors contributing to recent injury are discussed. Recommendations for correlating tree damage with sulphur dioxide emanations from refineries and for preventing recurrent damages are made.
Source: 1

1517

Linzon, S.N. "Ozone damage and semimature-tissue needle blight of eastern white pine." Can.J. Botany, 45:2047-2061 (1967).

Investigations were conducted in forests remote from large urban areas to determine whether there was any cause and effect relationship between naturally occurring atmospheric ozone and semimature-tissue needle blight (SNB) of eastern white pine (Pinus strobus). The daily average concentration of atmospheric ozone, relative to cracking by rubber test strips, was determined for three seasons, and no apparent relationship was found between excessive rubber cracking and the occurrence of outbreaks of SNB on susceptible white pines. The repeated application of vitamin C, a reducing agent, to newly developing needles of susceptible white pints, did not prevent the appearance of the symptoms of SNB or retard subsequent symptom development. In fumigation experiments with artificially produced ozone, concentrations of over 0.60 ppm as measured by the manual potassium iodide method, or 0.40 ppm by the coulometric method, were required to produce severe markings on the new needles of the white pine under study. Foliage on material derived from trees nonsusceptible to SNB was more responsive to these high concentrations of ozone and exhibited more uniform damage than foliage derived form trees susceptible to SNB. The macroscopic and microscopic symptoms of damage caused by excess ozone was dissimilar from the typical symptoms of SNB. The results of these investigations indicate that naturally occurring atmospheric ozone in stands of eastern white pine is not an incitant of SNB.
Source: 1

#1518
Linzon, S. N. "Fluoride effects on vegetation in Ontario." Preprint, International Union of Air Pollution Prevention Associations. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec 6-11, 1970, Paper MB-40A.) 56 p. (1970).

Vegetation studies were carried out during the growing season of 1969 in the vicinity of fluoride-emitting industries in four areas of Ontario, manufacturing aluminum, fiberglass, diammonium phosphate fertilizers, and superphosphate fertilizers, and located in or adjacent to urban, rural, or agricultural communities. Snow Princess variety gladiolus indicator plots were examined monthly for growth and per cent leaf tip-burn. At the end of the growing season the leaves were chemically analyzed for fluoride and chloride, and for boron at the fiberglass plant. The severity of fluoride injury found on vegetation at the sample stations in each area was related to the average concentrations of fluoride for the growing season found in the air and in the sampled foliage. High concentrations of fluoride were found in the atmosphere and in vegetation at the stations closest to three major sources of fluorides. Typical symptoms of fluoride-injury were observed on certain plant species. Atmospheric fluorides rarely injure flowers or fruit on plants. However, near the fiberglass plant, severe fluoride-injury was observed on the wings and seed casings of the key fruit of silver maple trees. The Snow Princess gladiolus plants exhibited severe leaf tip-burn and relatively high concentrations of fluoride within their leaves at the plots located closest to the three major sources of atmospheric fluorides. At these plots the corms were reduced in weight and size. Where both fluoride and boron were affecting gladiolus plants the symptoms of leaf injury were similarly those caused by fluorides alone, with the addition of necrotic lesions occurring below and confluent with the fluoride-induced tipburn. The uptake of chloride from the soil by the gladiolus plants were found to be drastically inhibited on the plots located closest to the major sources of fluoride where the gladiolus leaves had absorbed excessive amounts of fluoride from the air. Abatement measures undertaken by the superphosphate fertilizer plant prior to and during 1969 resulted in an average of 66 microgram f/sq cm being recorded at 16 air sampling stations during the growing season of 1969. This represented a drastic reduction from an average of 516 microgram f/sq cm which was recorded at the same 16 stations in 1965. Vegetation injury was slight and restricted to within one mile northeast and east of this fertilizer plant in 1969. Chloride uptake by the gladiolus plants was not inhibited in any of the indicator plots in this area.
Source: 1

#1520
Linzon, S.N. "Effects of Air Pollutants on Vegetation." In: Introduction to the Scientific Study of Atmospheric Pollution. B. M. McCormac (ed.), Dordrecht, Holland, D. Reidel Publishing, p. 131-151, 1971.

The effects of various air pollutants on vegetation are outlined. Information on symptoms of injury, dosages required to cause injury, sensitivity and tolerance of various plant species, and predisposing environmental and other factors are discussed. Consideration is also given to methods of investigating and preventing the effects of air pollutants on vegetation. The specific pollutants discussed include: sulfur dioxide, oxidants, ozone, O_3 and SO_2 synergism, peroxyacetyl nitrate, nitrogen oxides, fluorides, chlorine hydrogen chloride, ethylene, ammonia, mercury, and particulate matter.
Source: 1

#1519
Linzon, S.N. "Effects of sulphur oxides on vegetation." Forestry Chronicle, 48(4):182-186 (Aug 1972). Presented at the Air Pollution Control Association, Pacific Northwest International Section, Annual Meeting, Calgary, Alberta (1971).

The effects of sulfur oxides on vegetation are discussed, including a study made on the effects of sulfur dioxide on forests in the Sudbury (Ontario) mining district. Sulfur dioxide, entering leaves mainly through the stomata, is toxic to the mesophyll cells primarily due to its reducing properties. Acute leaf injury is caused by absorption of high concentrations of SO2 in a relatively short time, resulting in a rapid accumulation of sulfite which is toxic to the metabolic processes taking place in the mesophyl cells. Chronic injury is caused by long-term absorption of SO2 at sub-lethal concentrations. The sulfite is oxidized to sulfate at about the same rate that the gas is absorbed. When sulfate accumulates beyond a threshold value tolerable to the plant cells, chronic injury occurs. Sulfate is about 30 times less toxic than sulfite. Three large nickel and copper smelters are located in the Sudbury region which together discharge daily into the surrounding atmosphere over 7000 tons of SO2. Ten automatic SO2 recording machines were set out to determine the concentrations, frequency, and duration of atmospheric SO2 at strategic locations in the area. White pine trees were extensively damaged by sulfur fumes up to 25 mi northeast of Sudbury. Beyond this distance, the condition of white pine improved remarkably, where the concentration of atmospheric SO2 was consistently lower than 0.25 ppm. Toxic tolerances of various vegetation are listed.
Source: 1

#596
Lipman, C.B., and F.H. Wilson. "Toxic inorganic salts and acids as affecting plant growth." Botan. Gaz., 55(6):409-420 (June 1913).

The physiological effects of copper sulfate, zinc sulfate, manganese sulfate, and sulfuric acid emitted from smelter processes on plant growth were investigated. The plants were actually stimulated by quite considerable quantities of the toxic salts indicating a much greater tolerance than previously assumed. The limits of toxicity, therefore, must be studied in greater detail to determine what concentrations of the toxic salts will inflict injuries.
Source: 1

#1434

Liss, P. S. "Exchange of SO_2 between the atmosphere and natural waters." Nature (London) 233(5318):327-329 (October 1 1971).

The principal factors controlling the exchange of sulfur dioxide across air-water interfaces in the natural environment were studied to determine the rate of exchange of gas between the atmosphere and natural waters. Equations were computed for resistances of liquid and gas phases, and the ration of the gas to liquid phase resistance was calculated. For almost all environmental air-water interfaces, gas phase resistance controlled the SO_2 exchange rate. The behavior of SO_2 in crossing a natural air-water interface would therefore tend to resemble that of water vapor rather than oxygen of carbon dioxide. Based on these results, the vertical gradients of SO_2 and water vapor close to the sea surface should be similar, and the mean residence time for an SO_2 molecule in the atmosphere should be of the same order as that for a water molecule (approximately 10 days).
Source: 1

#597

Little, P. "A study of heavy metal contamination of leaf surfaces." Environ. Pollut., 5(3):159-172 (1973).

Leaves of Ulmus glabra, Crataegus monogyna, Salix alba, and Quercus robur which were heavily contaminated with aerial fallout of zinc, lead, and cadmium were subjected to several washing and extraction procedures. Large proportions of the metal burdens were present as superficial water-soluble, and insoluble deposits which could be removed by washing. Distribution of metals on and in the leaves varied significantly between different species. Each metal was distributed differently within the leaves of any one species. The results are discussed in relation to leaf cuticle structure, foliar-absorption, and uptake of metals from the soil. The very low proportions of metals released from leaves by boiling suggest that hardly any metal is likely to be present in the leaves which may induce metabolic toxicity. The uptake of metals by the deeper roots of trees may also be very slight based on concentrations of Zn which fall off so rapidly down the soil profile. These findings may explain why concentrations of up to 9000 ppm Zn in Elm leaves are not accompanied by symptoms of toxicity. The significance of heavy fallout may be a great importance to shallower rooting herbaceous species.
Source: 1

#152

Little P., and M. H. Martin. "A survey of zinc, lead, and cadmium in soil and natural vegetation around a smelting complex." Environmental Pollution, 3: 241-54 (1972).

Analysis of samples of leaves and soil collected in the Avonmouth area of Severnside shows the distribution of airborne zinc, lead and cadmium to be strongly affected by prevailing wind conditions. Levels of zinc, lead, and cadmium in elm leaves collected in October 1971 range from 8000, 5000 and 50 ppm dry matter respectively close to a smelting complex, to values of about 200, 100 and less than 0.25 ppm respectively at distances of 10 to 15 km from the factory. It is clear that considerable contamination of the natural vegetation has occurred, and is occurring in this area.
Source: 7

#1521
Little, P., and M. H.Martin. "Biological monitoring of heavy metal pollution." Environ. Pollut., 6(1):1-19 (Jan. 1974).

A simple, inexpensive technique is described for detailed monitoring of airborne metal pollution using Sphagnum moss suspended in fine nylon hair-nets from natural vegetation. The technique was used to monitor pollution month by month, at 47 sampling points near a zinc and lead smelting complex at Avonmouth, near Bristol, England. Maps of the area were constructed by computer, depicting the levels and patterns of distribution of Zn, Pb, and cadmium collected by the moss bags. The results are related to wind data, localized climatic conditions, and topography. The reliability and practical significance of this simple biological monitoring technique is discussed, with particular reference to the collection and retention of metals by natural vegetation. A comparison is made between moss bags and other monitoring devices. Sphagnum bags should be at least as valid as deposit gauges, if not more so.
Source: 1

#1522
Loetschert, W. and H. J. Koehm. "Baumborke als anzeiger von luftverschmutzungen." [Tree bark as indicator of air pollutants]. Umschau (Frankfurt), 73(13):403-404 (1973).

In the industrial area of Frankfurt, West Germany, the bark of deciduous trees acts as a useful indicator of air pollution. With increasing distance from the city, the Ph values of the bark increase and the sulfur content of the bark decreases. A linear dependence exists between sulfur content and pH value. The pH value of bark fluctuates between 2.7 and 4.35; the sulfur content fluctuates between 0 and 250 micrograms/sq cm. The Tiba platyphyllos, the Acer plantanoides, and the Fraxinus excelsior were found suitable as test trees.
Source: 1

#1938
Loewus, M.W., and C.C. Delwiche. "Carbon monoxide production by algae." Plant Physiol, 38:371-374 (1963).

Carbon monoxide production was demonstrated in Egregia menzies, several other algae, and in the higher plants, Zostera marina and Medicago sativa, by infrared analysis. Compounds involved in the production of CO were separated and identified by ascending chromatograpy. Oxygen is required for CO production by Egregia menzies. The ability to produce CO is not destroyed by heating the tissues. Properties of a CO-producing compound isolated from a 6-M sulfuric acid hydrolyzate suggest a polyphenolic compound. The instability of this compound is sodium methoxide and other alkaline solutions is characteristic of phenols with o-dihydroxy groups.
Source: 1

#1940
Loman, A. A., R. A. Blavel, and D. Hocking. "Sulfur dioxide and forest vegetation." Northern Forest Research Centre (Edmonton). (December 1972).

Sulfur is an essential element in plant metabolism. Sulfur is absorbed by the roots as sulfate ion, and enters the leaves as gaseous sulfur dioxide which dissolved in water to form sulfite ion. Conditions that favour good plant growth, increase the capacity of the plant to assimilate sulfur dioxide, but reduce the plant's tolerance to this gas. Foliar symptom development resulting from sulfur dioxide fumigations are described. Since foliar sulfur levels fluctuate in healthy leaves, foliar sulfur content is not suitable as a damage index parameter. Atmospheric sulfur dioxide levels can only be controlled at the stack. Rates of dispersion of known amounts of sulfur dioxide at the stack, are dependent upon uncontrollable factors of the environment. Similarly, tolerance levels of the vegetation surrounding gas plants, to sulfur dioxide fumigations, are dependent on uncontrollable factors of the environment. Monitoring devices which show cumulative concentrations of atmospheric sulfur dioxide levels, which must be averaged to arrive at daily or hourly concentration, are of limited use. It is the maximum, not the average or cumulative concentration that must be monitored. Sulfur dioxide concentrations will fluctuate constantly at any given point in the three dimensional space occupied by forests. Hence data obtained from monitoring stations must be extrapolated with caution. The green plant reflects the sum total effects of biotic and abiotic interacting factors of the environment. The green plant itself can therefore function as a monitoring device. Current ground level concentration standards in Alberta allow for 1.0 ppm of atmospheric sulfur dioxide for periods not exceeding one hour, during periods of flaring. This high concentration will be lethal to all Alberta forest species.
Source: 5

#598
Loomis, R. C. "Disease detection survey, air pollution, Arizona and New Mexico region 3." Forest Service, Albuquerque, N. Mex., Branch of Forest Insect and Disease Management, R-3 73-24, 128 p. (June 1973).

A detection survey was conducted to determine if sulfur dioxide from existing major sources was causing injury to forest vegetation in New Mexico and Arizona. In addition, background information was collected in areas where major sources are expected in the near future. Symptoms of acute SO_2 injury were found on Tonto National Forest, near Miami, Ariz; on the Coronado National Forest, near San Manuel, Ariz; and on the Apache National Forest, near Morenci, Ariz. Symptoms which resembled SO_2 injury; but which needed further evaluation, were noted near Hurley, N. Mex. No areas were found where trees were being killed by SO_2 fumigation.
Source: 1

#1524
Lundstrom, H. "Luftfororeningars inverkan pa epifytflo:an hos barrtrad i Stockholmsomradet." (The effect of air pollution on the epiphytic flora of conifers in the Stockholm region). Text in Swedish. Stud. Forest Suec., 56:1-55 (1968).

Epiphytic flora of conifers in the Stockholm region were investigated to see how they respond to air pollution. Three groups of lichens are apparent in terms of their relation to air pollution: species enduring air pollution in moderate quantities, e. g., Lecanora conizaeoides and Lecidea scalaris; species sensitive to air pollution for long durations; and the remainder of lichens which can be subdivided into those species growing close to the ground and sheltered by snow in the winter and species that may be affected by air pollution but can survive injuries within certain limits. The atmospheric algae Protococcus ciridis is only slightly affected by air pollution.
Source: 1

#1527

Lux, H. "Beitrag zur Trennung des Schadanteils Gleichzeiig auf die Waldvegetation einwirkender Abcasquellen." (Distinction between the respective shares of several, simultaneously acting gas emission sources in damages to sylvan vegetation). Text in German. Wiss. Z. Tech., Univ. Dresden, 15(6): 1533-1535 (1966).

A method for the distinction between respective shares of several, simultaneously-acting gas emission sources in forest damages is presented. Damage zone charts, elaborated on the basis of the symptoms of the actual forest damage, and charts of the pollutant concentration distribution for each individual emission source are necessary for this procedure. The concentrations are calculated with respect to fuel consumption, effective stack height, wind distribution and other meteorological conditions, distance between the emission source and the damaged forest, orographic conditions, and turbulence conditions. The sulfur dioxide distribution among the industrial plants responsible for the forest damages is calculated and graphically added up so that a chart of the total concentrations with relative SO_2 values is obtained. The damage area is determined planimetrically, and the value obtained for the area surface is multiplied by the concentration value. Industrial plants with high emission volumes are usually responsible for most damages. Plants with high stacks are responsible for less damages.
Source: 1

#1525

Lux, Herbert. "Studien ueber die kombinierten Einfluesse von basischen Staeuben und Schwerlf dioxid auf Kiefern und die Ausbildung von Humusfeldmen." (The combined effect on basic dusts and of sulfur dioxide on pine trees and the formation of humus forms). Polska Adaemia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 79-98 (Sept 9-14 1968).

The combined effects of kiln dust and SO2 emitted from a cement plant in Ruedersdorf, near Berlin, on a six-year old pine tree stand two km from the plant and the combined effects of fly ash and SO2 from the Zschornewitz power plant or pine trees one km away, were investigated. Damage to pine needles was assessed using a five-color shade scale

from green to completely brown. Pine saplings were not damaged by a thin cement kiln dust cover or the concomittant increase in soil pH to seven and eight. Needle necrosis was caused solely by SO2 (median long-term level not exceeding 0.20 mg/cu m). The higher soil pH did not increase susceptibility of the needles to change from SO2. The dust-covered needles had a healthy green color. In contrast, fly ash and SO2 from the power plants caused widespread necrosis of pine needles. This is attributed to the combined effect of the deactivation by high SO2 levels if enzymes responsible for the decomposition of the humus and the calcification of the soil by fly ash. In general particutate emissions alone are not responsible for substantial damage to vegetation except where dust contains phtotoxic components like chloride, sulfite, and arsenic.
Source: 1

#827
Lux, Herbert. "Ergebnisse einer Rauchschadendiagnose im Klosterborst Marienthal bei Ostritz (Neisse)." (Results of an air pollution diagnosis in the Kloster-forst Marienthal near Ostritz (Neisse)). Arch. Forstw., 19(2):99-106 (1970).

A forest district with moderate sulfur dioxide concentrations is used to demonstrate the fact that a sufficiently exact inventory of visually recognizable air pollution can be obtained both by exact enumertration sample plots and by visual estimation for whole stands. However, the results of both methods are not comparable in every case. Growth decrease calculated for sample plots cannot be applied to visually-estimated damage classes. The number of fatally injured trees has increased since 1964 and correlates with the damage classes used. Thus the method of using damage classes is adequate. Local distribution and temporal progress of the damage clearly points to power plants in the area. The annual loss of growth per hectare is calculated as a percentage of the yield table growth on local plants. Thus the loss of growth (cu m/hectare) can be ascertained by means of yield tables for every stand according to damage class, age class, and site class. A growth inventory for the entire district is no longer needed.
Source: 1

#1526
Lux, Herbert. "Immissionsschaeden in der Forstwirtschaft des Bezirkes Cottbus." (Emission injuries in forests of the District Cottbus). In: Technik und Umweltschutz LufteWasser - Boden - Laerm, Luftverunreinigung bestimmter Gebiete und technologische Verfahren zur Emissionsverminderung, Vol 5, Leipzig, VEB Deutscher Verlag fuer Grundstoffindustrie, p. 58-62 (1974).

Immissions from the power plants Luebbenau and Vetschau led only recently to injuries of pines in the state-owned forests of Cottbus and Luebben. Very recently pine injuries from combustion of natural gas in flares have been discovered in an area spanning 300 hectares. On

the leeward side of the combine Black Pump sulfur dioxide and sulfur trioxide injuries of pines were discovered. In an area of about 15 hectares only about 20% of the trees seem to be unaffected,740 more hectares are affected but to a lesser degree. In the vicinity of the chemical plants Schwarzheide, Lauchhammer, and Ruhland SO2 and chlorine emissions have injured the neighboring coniferous and deciduous trees. The dying rate of trees was determined in the older tree populations of the state-owned forests of Luebben, Cottbus, Hoyerswerda, and Weisswasser. In the period from 1964 to 1970 11.4% of the total number of pines died in the observation area around the mine and power generation combine Black Pump and the chemical plant Schwarzheide; in Luebbenau-Vetschau the percentage was 9.6; and in the areas more remote from emission sources the percentage ranged around 3 or 3.4.
Source: 1

#1528
Lvov,Y.A., N.V. Vasil ev, and G.M. Ivanova. "Metod issledovaniya dinamiki vypadeniy promyshlennoy pyli na boil shikh ploshchadyakh." (Study of the dynamics of industrial dust fallout over large areas). Text in Russian. Gigiena i Sanit., 8:97-98 (1974).

A method for the study of the dynamics of the fallout of magnetic and silicate dust of industrial origin over large areas by means of biological indicators is described. Sphagnum fuscum (Moss) growing in bogs and retaining dust particles is used for this investigation. The samples taken from the upper 50-55 cm layer are washed and incinerated, after which the ash is washed with water for the leachout of water-soluble particles, and finally dried. The dried residue is observed under the microscope. The presence of spherical particles ranging from 10 to 150 microns in diameter is indicative of industrial dust fallout. The observations of samples from different depth permits the dynamic study of dustfall over large areas.
Source: 1

#1611
Lynam, D. R., Ph.D. "The atmospheric diffusion of carbon monoxide and lead from an expressway." University of Cincinnati (1972).

This field investigation involved the use of carbon monoxide as an inert tracer to evaluate the transport and removal of lead particulates after their emission into the atmosphere by studying the relative behavior of the two materials. Multiple linear regression analysis and the statistical Gaussian diffusion model were utilized in predicting the atmospheric dispersion of lead and carbon monoxide from a high speed, heavily travelled expressway.

Atmospheric samples of carbon monoxide and lead were collected continuously for 30-minute sampling periods and simultaneously at seven sampling sites positioned at logarithmic intervals of 20, 40, 80, 160, 320 and 640 feet from the edge of an expressway. Background levels were obtained at a sampling site located upwind of the expressway. Corresponding meteorological and traffic data were recorded in order to compare the results to model forecasts.

The maximum atmospheric concentration of lead measured in this study, which involved approximately 350 samples, was 15.08 ug/m^3. This value was measured at the sampling station located 20 feet downwind from the edge of the roadway during stable atmospheric conditions and a traffic volume of 4844 vehicles/ 0.5 hour. The maximum atmospheric concentration of carbon monoxide was 10.5 ppm, which was also measured at the sampling station located 20 feet downwind from the edge of the roadway during stable atmospheric conditions and a traffic volume of 4682 vehicles per 0.5 hour. The mean lead and carbon monoxide levels, which were measured upwind of the expressway and represented background levels, were 0.4 ug/m^3 and 1.5 ppm respectively.

The data indicated that the removal of lead particulates emitted in automobiles exhaust was of important magnitude varying from approximately 2.5 percent over a travel distance of 20 feet, which was the minimum travel distance to approximately 50 percent over a travel distance of 620 feet, which was the maximum travel distance studied. Therefore, the atmospheric half-life for airborne lead emitted from automobile exhaust, downwind of an expressway, was equivalent to the time required for the plume to travel 620 feet over open terrain consisting primarily of dense grass. The major portion of the lead particulates emitted in automobile exhaust is therefore removed rather rapidly by dry deposition, which includes the mechanisms of sedimentation, impaction, Brownian motion, coagulation, and eletrostatic attraction although the actual physical phenomena may be very complex. The mass median equivalent diameter (MMED)for atmospheric lead particulates is approximately 0125 micrometers, a size which is not greatly influenced by the mechanism of sedimentation.

The linear relation between lead and carbon monoxide was highly dependent on the sampling location with respect to the expressway. Lead and carbon monoxide were highly correlated especially at distances close to the expressway, but the regression of lead on carbon monoxide varied with the distance of the sampling site from the expressway. The data clearly illustrated that atmospheric lead levels cannot be accurately predicted from atmospheric carbon monoxide levels or conversely.

Traffic volume, log of the distance from the edge of the expressway, and wind speed were statistically significant variables in multiple linear regression models for predicting atmospheric concentrations of carbon monoxide and lead. A multiple linear regression model for lead which was developed from the study also proved to be a reliable predictor of lead concentrations which were obtained from independent studies previously published in the literature.

The statistical Gaussian diffusion model, which was modified to include multiple infinite line sources, was a good predictor of atmospheric carbon monoxide concentrations downwind of an expressway. The levels of lead predicted by the Gaussian model were approximately two times greater than the observed values. reflecting depletion of lead particulates in the plume. The assumption of complete reflectinn of the plume from the earth's surface in the derivation of the Gaussian model was invalid for the lead particulates, and approxpriate corrections are required for accurate predictions of atmospheric lead levels by the Gaussian diffusion model.

The results of this study should be useful to urban planners, highway design personnel, air pollution control officicals, and environmental scientists who are concerned with traffic emmissions, air quality standards, the transport and removal of traffic emissions, and air quality implementation plans. The results of this study can be applied to other automotive pollutants to determine their behavior in and effect on the environment.
Source: 3

#1529
Ma, Te-Hsiu, Djoko Isbandi, Shaukat H. Khan, and Ya-Shiu Tseng. "Low level of SO2 enhanced chromatid aberations in Tradescantia pollen tubes and seasonal variation of the aberration rates." Mutat. Res., 21(2):93-100 (April 1973).

Pollen tube cultures of the herb Tradescantia paludosa Anders, Sax clone-3 were grown on microslides coated with lactose agar medium (0.02% colchicine). There were incubated in an air tight moist chamber for 18hr to obtain the metaphase chromosomes of the pollen tube generative nuclei. Sulfur dioxide treatments were applied at the beginning of the germination stage, 7-10 min after sowing the pollen. A total of about 0.075 ppm of SO2 was used for the entire incubation period. Sulfur dioxide was either generated by the reaction between K25205 and hydrogen chloride inside the chamber or obtained from diluting the gas from commercial SO2 gas of known concentration through a gas dilution system. Full-grown cultures fixed in Gate s fluid and stained in Feulgen were made into permanent slides for aberation-rate determination. Year-round study of SO2 effect on chromosomes was made possible by using a GRO-LUX lamp (Sylvania) illuminated incubator, in winter, to promote mitotic activity of pollen culture. In these studies, SO2 enhanced chromatid aberration rates (average 46 breaks/100 cells) in the cultures grown from field or hot-house plants during three consecutive summers (1970-1972). There was a gradual decrease in the fall and a gradual increase in spring in both background and enhanced abberation rates. When summer pollen cultures from GRO-LUX lamp pre-conditioned (7-20 days) plants were treated with SO2 in the same chamber with those grown from summer hot-house plants. High rate (42 breaks/100 cells) of aberration was observed only in cultures from summer hot-house plants.
Source: 1

#1530
MacDonald, D.W., M.A. Lamoureux, M. Van den Brink, G.R. Whenham, and W.P. Brisbane. "Chlorine gas poisoning in farm livestock: Case report and review." Can. Vet. J., 12(2):33-40 (Feb 1971).

The accidental release of approximately 15 tons of chlorine gas is described. Vegetation on farms and roadsides in the affected areas suffered damage: the leaves on trees were darkened, and coniferous trees were affected so that the needles dropped. Feed samples, although of generally poor quality due to difficult harvesting conditions, showed no significant changes in pH or chloride ion content when compared with samples collected from nonaffecting areas. Soil analyses showed no chlorine accumulation and no differences which could be attributed to chlorine exposures Forage from the affected area had no harmful effects on three calves fed on it for one week, and there was no observable loss of palatability. Egg, milk, and cream samples showed no abnormalities when examined by a taste panel. Farm livestock including pets became sick, and in some cases died, following exposure. Several cattle died, and post mortem lesions consisting primarily of edema and emphysema of the lungs were observed. Pigs became sick, but recovered in most cases. Pet animals and poultry appeared to recover fairly quickly, while horses were more severely affected clinically and may have sustained permanent damage to the lungs.
Source: 1

#217
MacDowall, F.D., E. I. Mukammal, and A. F.W. Cole. "Direct correlation of air polluting ozone and tobacco weather fleck." Can. J. Plant Sci. (Ottawa), 44: 410-7 (Sept. 1964).

Influxes of polluted air and attacks of tobacco weather fleck in southwestern Ontario were accurately forecast from the synoptic weather pattern and from considerations of mesoscale meterological systems. However, the principal air pollutant, ozone, occurred daily at low concentrations, that was often not followed by corresponding amounts of damage. This difficulty was largely removed by modification of the dose term with the coefficient of evaporation. The latter may empirically represent physiological and physical factors affecting gas exchange. A related downward flux of ozone might be important in determining the amount of ozone available for absorption. The threshold does of air-polluting ozone and experimentally generated ozone were approximately the same.
Source: 1

#1531
MacDowall, F.D.H. "Importance of soil in the absorption of ozone by a crop." Can. J. Soil Sci., 54(2):239-240 (May 1974).

The absorption of ozone by the soil in a field crop was measured. The O3 concentration in a closed tent covering tobacco plants fell from the steady state concentration by a first order decay process suggestive of diffusion to reactive surfaces. The rate of this decay, as measured by the first order rate constant, depends mostly on the nature of the tent floor. The decay was slowest in the blank runs with the empty tent and plastic floor. Rapid decay occurred in tents with the unwatered field soil. The addition of the full leaf area index of a mature tobacco crop increased the rate of decrease of ozone concentration inside the tent significantly on the average, but not by more than half.
Source: 1

#599
Macdowall, F. D. H., and A. F. W. Cole. "Threshold and synergistic damage to tobacco by ozone and sulfur dioxide." Atmos. Environ., 5-553-559 (July 1971).

Fumigation of greenhouse grown tobacco with ozone corroborated the approximate threshold dose of 20 pphm/hr as observed in the field. Synergism between 03 and sulfur dioxide was confirmed but it was not obtained with S02 at a dose an order of magnitude less than the 03 threshold dose as they occurred in the field. Synergism did not lower the threshold dose of 03. The synergistic mixtures were twice as potent as the added effects of the components.
Source: 6

#219
MacIntire, W. H. "Air Versus Soil as Channels for Fluoric Contamination of Vegetation in Two Tennessee Locales." Louis C. McCabe,(ed.). Interdepartmental Committee on Air Pollution, Washington, D. C., Air Pollut., Proc. U. S. Tech. Conf., Washington, D. C., p. 53-58, May 3-5, 1950.

Long-term (20-year) field and experimental studies are reported of the processes through which forage vegetation may acquire an abnormal fluorine content; the work was initiated in response to complaints that fluorine emissions from nearby industry were causing damage to plants and livestock. Results indicate that soils possess distinctive capacities to fix additive fluorides against rainwater leaching and against migration of the fluorine ion into above-ground forage crops, and that such migration is repressed in soil systems that contain adequate supplies of calcium. Abnormal fluorine content in the vegetation of certain locales in Blount County (eastern Tenn.) is attributed to direct contamination from the hydrofluoric acid that is emitted to the atmosphere through the manufacture of aluminum. In the absence of fluoric dusts and without mechanical pollution from phosphatic soils, fluoric contamination of forage vegetation in Maury County (middle Tenn.) apparently comes directly from the fluoric effluents present in that atmosphere, rather than through uptake of fluorides from the soil.

Source: 1

#218
MacIntire, W.H., et al " Effects of fluorine in Tennessee soils and crops." Ind. Eng. Chem., 41(22):2466-2475 (Nov. 1949).

Findings are reported from 20 years of experimentation upon the fate of soil incorporations of various fluoric materials such as insecticides, fertilizers, sodium, potassium, and magnesium fluorides, slags, rock phosphate, and cryolite through determinations of induced chemical and bio-chemical phenomena, retention of fluorine against lysimeter leachings of rainwaters, and fluorine content of roots and top growth in greenhouse cultures. The early lysimeter experiments and greenhouse studies as to uptake of fluorides were extended to ascertain fluorine occurrences in the atmosphere, in rain water in soils, and in vegetation on farms in locales where injurious effects upon plant and animal life were purported to have been caused by atmospheric effluents from the increased manufacture of aluminum in Blount County in east Tennessee and from expanded operations in the processing of rock phosphate in Maury County in middle Tennessee. Soils possessed remarkable retention of the fluorine carried by insecticides, fertilizers, and various fluoric compounds, while yielding abnormal concentrations of fluorides to the rain water leachings from incorporations of electric furnace slag. Vegetation effected virtually no enhancement in the uptake of fluorine from soils that possessed adequacy of calcium, either naturally contained or added. Comparative analyses of crops grown in soils, in place and after transportation to unaffected points, served to support the conclusion that abnormal incidence of fluorine in field vegetation is attributable to atmospheric contaminants.

Source: 1

#1532

Mack, D. and H. Berg. "Bestimmung von Blei in Gemuese und Obst, einschliesslich Weintrauben, durch Atomabsorptionsspektrophotometrie." (Determination of lead in vegetable and fruit including grapes by atomic absorption spectrophotometry). Deut. Lebensm. Rundsch., 68(8):262-263 (1972).

An atomic absorption spectrophotometric method was used to determine lead in 100 fruit and vegetable samples which grew along a street. After wet incineration of the vegetation, lead was completely linked to ammonium pyrolidine dithiocarbamate and was determined in a methyl-ketone phase. Lead concentrations smaller than 0.05 and 2 mg/kg were measured. Lead in grapes taken from alongside roads of different classification was also measured. Lead concentrations slightly exceeded normal concentrations in a few cases of plants growing next to streets.
Source: 1

#1533

MacLean, D. C., and R. E. Schneider. "Fluoride accumulation by forage: continuous vs. intermittent exposures to hydrogen fluoride." J. Environ. Quality, 2(4):501-503 (October-December 1973).

The effect of continuous versus intermittent exposures to hydrogen fluoride was investigated with timothy (Phleum pratense L.,) and red clover (Trifolium pratense L.) plants. Fluoride accumulation was greater after continuous fumigations than when the same HF does was provided in alternate 48 hr exposures. The importance of the intermittent nature of exposures in addition to the pollutant concentration and duration of exposure in governing F accumulation suggests that pollution abatement action to protect livestock from ingested F should be based on the F content of forage rather than the concentration of airborne fluorides.
Source: 1

#345

MacLean, D. C., R. E. Schneider, and L. H. Weinstein. "Accumulation of fluoride by forage crops." Contrib. Boyce Thompson Inst., 24(7):165-166 (1969).

Portions of mixed timothy and red clover exposed to hydrogen fluoride that averaged 7.0 micrograms F/cu m over a 14-day period rapidly accumulated F, attaining a concentration of more than 100 ppm within three days and about 400 ppm by the end of exposure. The plants showed severe HF-induced foliar symptoms. Forage exposed continuously to a HF concentration that averaged 1.6 micrograms over the 14-day period accumulated 37 ppm F by the end of exposure. In contrast, forage exposed intermittently to a 14-day mean concentration of 1.0 micrograms F/cu m accumulated 101 ppm F after only 1-day of exposure. However, there were no discernible differences in the extent and severity of foliar injury following continuous low and intermittent HF exposures. Presumably the intermittent nature of the exposure provided sufficient time for the detoxification of the absorbed F. These data suggest that F accumulation by forage is at best a poor indicator of fluoride pollution, except when used for the protection of livestock or confirmation of suspected fluroride-induced foliar symptoms.
Source: 1

#1946

Macrae, I.C. and R. Ancajas. "Volatilization of ammonia from submerged tropical soils." Plant and Soil, 33:97-103 (1970).

A laboratory study was made of the losses of nitrogen through ammonia volatilization from four flooded, tropical soils. The soils used varied considerably in pH, organic matter content, and cation exchange capacity. Losses were measured from the unamended soils, and from ammonium sulphate and urea-treated soils. Two rates of nitrogen application (approximately 50 and 200 kg/ha N) and two methods of application (simulated field broadcast and fertilizer incorporation) of the nitrogen were used. Losses of ammonia were detected for each of the unamended soils, including an acid sulphate soil of pH 3.6. Increased application of both ammonium sulphate and urea resulted in increased losses of ammonia through volatilization. Incorporation of the nitrogen into the mud of the flooded soils significantly decreased losses due to volatilization. It was concluded that the initial or "aerobic" pH of the soils was the soil characteristic most closely related to the magnitude of losses due to volatilization.
Source: 5

#220

Macris, B.J. "Transport and toxicity of sulfur dioxide in the yeast Saccharomyces cerevisiae var. ellipsoideus." Michigan State Univ., Dept. of Food Science and Human Nutrition, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 104 p. (1972).

Investigations conducted on the transport and toxicity of sulfur dioxide in the yeast S, cerevisiae, var. ellopsoideus revealed a mediated transport system for SO_2 and a cell growth suppression dependency upon the amount of molecular SO_2 and the time period of contact with the cell. Molecular SO_2 was the only form transported; bisulfite and sulfite ions were not taken up by the yeast. Not all of the transported SO_2 was retained within the cell, and a certain portion of it could be removed by washing. The amount of SO_2 taken up was increased as the pH value of the incubation mixture was decreased. The transport system operated very rapidly, and SO_2 reached its maximum level in about 2 min. Two equilibria were involved in the transport; the first, a chemical equilibrium, regulated the availability of substrate (molecular SO2) to the transport; and the second regulated the inward and outward fluxes of SO_2 across the cell membrane. Kinetic data showed that the transport was saturable, and the system was temperature dependent and irreversibly heat inactivated. The relationship of cell viability and time to SO_2 exposure was linear on a semilog plot. Preliminary study of the localization of 35S in cells exposed to $^{35}SO_2$ showed that SO_2 was not actively metabolized, and practically all the SO_2 which reacted within the cell was found in the small molecule fraction. Sulfur dioxide most likely reacts with compounds containing carbonyl groups as well as with other molecules inhibiting various steps which cause termination of cell growth.
Source: 1

#292
Madelaine, G., and A. Renoux. " L aerosol atmospherique. Sa nature et sa mesure." (The nature and measurement of atmospheric aerosol). Text in French. Pollut. Atmos. (Paris), 64:389-397 (Oct.-Dec. 1974).

The origin, nature, and measurement of atmospheric aerosol are reviewed with special reference to the lower troposphere. Natural aerosols are formed from soil and rocks, from sea salts, volcanic activity, hydrocarbons of plant origin, and from reactions of gases, such as hydrogen sulfide, oxides of nitrogen, and ammonia. Anthropogenic aerosols originate from direct particulate emissions, particles formed by gaseous-phase reactions of sulfur dioxide and nitrogen oxides, and from hydrocarbons. The background aerosol to be found in non-polluted areas has a concentration of about 700/cu cm, and the particle size is usually greater than 0.1 micron. Oceanic aerosol has a concentration of less than 10 particles/cu cm, and is in a concentration range of 0.5-20 micron. Continental aerosol in polluted areas has a concentration maximum around 0.03 micron and below 0.01 micron. The concentration ranges from 1000 to 100,000/cu cm. Photoelectric instruments, such as aerosol spectrometers and condensation nuclei counters are most important in aerosol studies, their lower detection limit having been lowered to 0.06 micron. Microscopy, especially electron microscopy, is rather sophi s ticated for aerosol investigations. Electrostatic precipitators are most promising in this area.
Source: 1

#388
Maeno, M. "Jumoku ni taisuru taiki osen no eikyo. (4). Gairojuyo no iwokeitai no jikitek henka." [Effects of air pollution on trees. Part IV. Seasonal changes of sulfurous constituent in leaf of street trees]. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):135 (1969).

There is a close relationship between sulfur dioxide concentration in air and sulfur content in trees, and the long-term contact of trees with sulfur dioxide gas in air pollution apparently leads to the decline of their population. However, since sulfur is relatively abundant in soil and is an important constituent of a tree, it is difficult to determine the absolute quantity of sulfur that invades the tree through the leaves. Planted trees along the streets (gingko, platanus, Chinese parasol, and horse chestnuts) from ten industrial as well as non-industrial locations in the Tokyo-Yokohama area were tested for sulfur content by means of fractional quantitative analyses according to water-soluble, acetate-soluble, and insoluble categories of sulfur compounds. Seasonal fluctuations in the sulfur concentration in the leaves were recorded for trees in the industrial areas and non-industrial areas and the results were compared.
Source: 1

#387
Maeno, M. "Jumoku ni taisuru taiki osen no eikyo: dai-goho. Gairojuyo no jukinzoku. Genshikyukoho ni yoru namari no sokuteiho no kento to sokutei-rei." (Effects of air pollution on trees. V. Heavy metals in leaf of street trees studies on determination of lead by atomic absorption spectroscopy and results of some measurements). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):136 (1969).

The effect of pollution on plants and trees from automobile exhausts was estimated by measuring the distribution of lead content of trees by means of atomic absorption spectroscopy. Attention was paid to the conditions of observation, the effects of coexisting elements, the methods of decomposing the samples, and the rate of data retrieval. Gingko, platanus, Chinese parasol, and horse chestnut trees were observed from ten locations in the Tokyo-Yokohama area. Gingko ranged from 17 to 116 ppm with an average of 49 ppm in lead content, and platanus ranged from 17 to 34 ppm with an average of 25 ppm. The locational difference in the contents indicated that there is a close relationship between lead content and traffic volume; and in addition, the period of June to July was the time of increase of lead content. The dust (insoluble components) on the leaves had values ranging from 650 to 1318 ppm with an average of 932 ppm.
Source: 1

#221
Maeno, M. "Jumoku ni taisuru taiki osen no eikyo (dairoppo) Gairyojuyo no jukinzoku. Tetsu oyobi mangan." (Effects of air pollution on trees (VI) Heavy metals in leaves of street tree and manganese). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):155 (1970).

Iron and manganese content resulting from air pollution was examined in trees bordering highways between Yokohama and Kawasaki between May and June in 1967. Chloric solution of ash from 74 trees (11 species) from 59 locations were separated into various metal classes by the atomic absorption method. Metallic content, location, and the relationship of the content with the insolubles on the leaf surface were examined. Further periodical checks were made in 1968 and 1970; the average increase in iron values in leaves in three years was greater in ginko (380 to 2820 ppm) and in sultan's parasol (640 to 3160 ppm). Others such as Carolina poplar (310 to 710 ppm) and willow (340 to 770 ppm) showed relatively low values and little change. In all categories, higher metal values were detected in trees in industrial areas than those in commercial or residential areas. Geographical differences were especially manifest in ginkoes and sultan's parasols. Both manganese and iron values in May and June were relatively low and much higher after July. The iron content in ginko showed a 10% drop between 1967 and 1970, and the manganese content a 20% drop. Part of heavy metal in tree leaves was obviously absorbed from the soil, but a large part of metal content seemed to have come from the soil, but a large part of metal content seemed to have come from the insoluble dust particles from the leaves in polluted industrial areas.
Source: 1

#232

Maeno, M. "Jumoku ni taisuru taiki osen no eikyo (dainanaho) Gairojuyo no jukinozoku. Aen oyobi do." (Effect of air pollution on trees (VII) Heavy metals in leaves of street tree). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):156 (1970).

Zinc and copper values in trees were examined. The zinc content in ginko was 15-17 ppm; in sultan's parasol, 40-220 ppm; in Carolina poplar, 100-300 ppm; and in willow, 30-430 ppm. The fluctuation of zinc values in comparison to other metal values seemed larger in general, but especially in willow and sultan's parasol. All trees showed higher zinc values in the industrial area; they were 60-90% (commercial areas) and 30-60% in (residential areas) of those in the industrial areas. Copper value differences were smaller in comparison to manganese or zinc value fluctuations. Copper content in ginko was 10-45 ppm; in sultan's parasol, 20-60 ppm; in Carolina poplar, 15-20 ppm; and in willow, 10-15 ppm. Periodical checks showed that ginko trees in all areas but especially those in the Kawasaki industrial area increased their zinc values greatly in August and September. Ginko's zinc and copper content decreased in all areas between 1967 and 1970; zinc content decreased 40% and copper content 20%. The heavy metal content in the insoluble material on tree leaves in 1968 included 210-890 ppm zinc and 250-760 ppm copper, and indicated a great geographical difference.
Source: 1

#828

Maeno, M. "Taiki osen busshitsu ni yoru shokubutsu higai." (Damage to plants by air pollutants). Text in Japanese. (Presented at the Association of Safety Engineering Seminar, 17th, Yokohama, Japan, Feb. 1970.) Preprint, Association of Safety Engineering, Yokohama (Japan), 40 p. (1970).

Plant resistance to various pollutants, environmental factors, damage to plants, diagnosis of the causes of damage and measurement of harmful substances in plants by chemical and physico-chemicalanalysis are described. It is desirable to cultivate the type of plants which are sturdy enough to resist poor environmental conditions, and efforts must be made to study the appropriate species and fertilization and cultivation methods. An equation for estimating the yield of plants damaged by sulfuric acid is given. The Kosaka method of measuring the damage to paddy rice by sulfuric acid gas averages the rate of adsorption of sulfuric acid gas and the rate of Mosaic lesions of leaves by gas damage. Physico-chemical analysis confirms the harmful substances and traces the change in physiological functions by using infrared ray absorption spectrum analysis. Gas chromatography is used to determine the concentration of formic acid in plants which were damaged by smog. Since it is almost impossible to confirm pollutants that originate in smog, ozone, nitrogen oxides, and exhaust gases from automobiles, it is important to measure the harmful substance in the atmosphere. Many of the harmful gases have strong acidic reactions, so that when they accumulate in the soil, they have serious effects on soil mechanisms.
Source: 1

#1534

Maeno, M. "Taiki osen to shokubutsu gunraku." [Air pollution and plant community]. In: Data on Pollution, No. 34: Environmental Protection Bureau, Yokohama City--Special Series City Environment and Biological Index. Yokohama. 21-28 (April 1972).

The threshold of plant damages by pollutants such as ozone, peroxyacetyl nitrate, nitrogen dioxide, sulfur dioxide, hydrogen fluoride, chlorine, and ethylene, the general damage symptoms, the location of damages on plants, and vulnerable parts in plant structure are discussed and presented in a table. The external appearance of plant damage can be used as an index for air pollution. With some fluctuation by tree types, trees such as zeikova, gingko, and plane follow certain curves formed by damage indexes and the distances from the industrial areas. Also, the relationship between sulfur oxide concentration in the air and the sulfur trioxide content in the leaves of gingko forms a linear graphic relationship. The effect of SO2 on the general deterioration of trees and the sulfur content of tree leaves seem to have a certain relationship. Most of the SO2 gas absorbed through the leaves into plants is accumulated as inorganic sulfuric acid ion, and very small amount changes into organic sulfur. The degree of sulfur degradation in plants is clearly different by the geographical locations of the plants, and in heavily polluted areas, the sulfur content in gingko leaves increases as time passes and reaches as high as 1.4% before the leaves drop. The portion that increases is soluble sulfur, and insoluble organic sulfur seems to remain at the same level. There is not much geographical difference in the amount of organic sulfur. Therefore, as an air pollution indicator, soluble sulfur, or the ratio of soluble sulfur to the total sulfur content in the tree should be considered.
Source: 1

#601

Maeno, Michio. "Taikiosen to Shokubutsu Gunraku." (Atmospheric pollution and botanical group growing). Kankocho Kogaisenmon Shiryo (Public Nuisance Gaz.), 3:58-64 (April 1972).

A botanical index for the evaluation of atmospheric pollution is examined. Plants can be affected by sulfur dioxide, fluorides, chlorine, nitrogen oxides, ozone, hydrogen sulfide, ethylene, dust and peroxyacetyl nitrate. Type of damage in plants depends on the difference in pollutants. The Science and Technology Agency has investigated four kinds of deciduous trees and five kinds of evergreens. The period of the investigation was from the last part of July to the last part of August, and for the investigation of defoliation, after the first part of October. Surveyed areas were six spots 2, 4, and 6 km to the west, 12 km to the west northwest, and 12 and 25 km to the northwest of the seaboard industrial belt area. The relationship between distance from the industrial belt area and degree of damage is given. The relationship between concentration of sulfur oxides in the air according to the lead dioxide method and sulfur content in ginkgo leaves is a close correlative relationship. Use of the botanical index for evaluation of atmospheric pollution has a bright future, and in order to get the widely spread information, it is necessary to patternize and computerize the subjects of investigation. The specific gravity of each of the investigation items should be compared with the comprehensive plant vitality.
Source: 1

#602

Maeno, M. "Jumoku ni taisuru taiki osen no eikyo (Daikyuho) Gairo juyo no fusso kanryo." (Effects of air pollution on trees (IX) fluorine in leaves of street tree). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):154 (1971).

The fluoride contents of street trees in various areas were studied. Fluorines were mainly discharged as hydrogen fluoride and silicon tetrafluoride. The tolerance threshold of plants to fluorides was as low as 1-10% of tolerance to sulfur dioxide. Fluoride content in leaves of paulownia sampled in May 1967 was highest value at 1600 ppm and averaged at 409 ppm. The average concentration in leaves of the maidenhair tree was 193 ppm; that of the willow was 97 ppm. Average concentrations in leaves of trees in commercial and residential areas were as low as 10-30% of concentrations in industrial areas. Fluoride concentration slightly increased in the residential area from 1967 to 1970 but remained unchanged in commercial areas and decreased in industrial areas. High fluoride content was also measured in the soil of industrial areas.
Source: 1

#603

Maeno, M. "Baijinchu no kinzoku seibun no juinoku e no eikyo." [Effects of heavy metals in dust on trees]. Kogai to Taisaku (J. Pollution Control), 8(6):535-542 (June 1972).

Metal contents in trees were investigated at two major cities of Kanagawa Prefecture. Iron was found in the largest concentration, followed by zinc, manganese, lead, copper, nickel, chromium and cadmium. All the metal contents were higher in trees in industrial areas than in those in commercial and residential areas. The average metal content of particulates on the leaves of seven kinds of trees in an industrial area in Kawasaki City were 86.7 mg/sq m leaf area for Fe, 1.33 mg/sq m for Mn, 1.07 mg/sq m for Zn, 0.34 mg/sq m for Pb, 0.14 mg/sq m for Cu, 0.11 mg/sq m for Ni, and 0.004 mg/sq m for Cd. The average components of particulates on the leaves of trees in an industrial area were 38.1% silicon dioxide, 14.1% aluminum oxide, 18.3% ferric oxide, 7.2% calcium oxide, 1.8% magnesium oxide, and 9.6% sulfur trioxide, and those in a non-industrial area were 45.3%, 16.6%, 8.8%, 6.2%, 2.0%, and 8.5% respectively. Investigations on the growth of trees revealed that new leaves in industrial areas had smaller leaf areas and poor growth conditions.
Source: 1

1937

Majernik, O., and T. A. Mansfield. "Stomatal responses to raised atmospheric CO_2 concentrations during exposure of plants to SO_2 pollution." Environ. Pollut., 3(1):1-4 (Jan. 1972).

Stomata provide the main routes for entry of pollutants into the leaves of higher plants, and it has been suggested that iniators of stomatal opening could be used to protect plants against pollution. Experimental evidence is presented indicating that the stomatal closing response to carbon dioxide still occurs in the presence of sulfur dioxide, even during conditions in which sulfur dioxide alone stimulates stomatal opening. The increases in carbon dioxide concentration that occur in polluted atmospheres appear to be sufficient to cause partial stomatal closure. The variability between individual plants in the magnitude of the stomatal response to carbon dioxide is considerable, and the response could be one useful criterion to employ for selective purposes when crop varieties are produced for growing in polluted areas. Plants of broad bean were used in the experiment.
Source: 1

#1535

Majerus, P. and S. Denaeyer. "Contribution a l etude de la pollution de l ecosysteme urbain Bruxellois par les metaux lourds." [Contribution to the study of the pollution of the Brussels urban ecosystem by heavy metals]. Commission of the European Communities, Luxembourg, and Environmental Protection Agency, Washington, D. C., Proc., Int. Symp., Environ. Health Aspects Lead, Amsterdam, Netherlands. EUR-5004, 7 p. (May 1973).

Leaves taken from Robinia pseudoacacia L. at 2.50 height, and from Platanus hybrida Brot. at 3.50 m height at sites with different traffic densities in Brussels at the end of the dry summer of 1971 were analyzed for lead, silica, iron, and other heavy metal contents by atomic absorption spectrophotometry. The Pb contents in locust leaves taken from sites with heavy traffic, moderate traffic, light traffic were in the respective ranges of 340-129 mg/kg dry weight, 120-61 mg/kg, and 88-27 mg/kg. Locust leaves taken from parks contained 35-72 mg of Pb per kg. The Fe contents in leaves taken from the four different sites were in the ranges of 3720-1140, 1480-850, 910-200, and 1030-440 mg/kg, respectively. Correlation factors of 0.98; 0.95; 0.95 and 0.92 for the Pb-Fe concentrations, Pb-copper concentrations, Pb-zinc concentrations, and for the Pb-SiO2 concentrations were obtained. Close correlation between the Pb contents in the leaves and the amount of traffic was established. Washing the leaves eliminated over 50% of the Pb accumulated.
Source: 1

#974

Makarov, B. N., and V. V. Dokuchayev. "Liberation of NO_2 from soils." Soviet Soil Sci., 1:20-25 (1970).

The results of a study of the causes of formation and liberation of nitrogen dioxide from Sod-Podzolic soils and thick Chernozem are reported. The formation and liberation of nitrogen dioxide from soil were found to be related to the activity of photosynthesizing microorganisms which reduce nitrates to nitrites. The latter are decomposed to form NO_2 that is released from dry soil into the atmosphere.
Source: 5

#1536

Mako, M. and M. Shinozaki. "Yugai gasu ni yoru shokubutsu higai no kaiseki (1)-d. mikan ni taisuru ozon, aryusan gasu no eikyo shiken." (Analyses of plant injuries due to harmful gases: Part I. Sec. D. Experiments on the effect of ozone and sulfur dioxide on Citrus unshu). Kanagawa-ken Nogyo Sogo Kenkyujo Gyomu Nenpo (Ann. Rep. Kanagawa Prefect. Agr. Integr. Inst.), 1973:72 (June 1974).

Two-year old trees of Citrus unshu were exposed to ozone, ozone than sulfur dioxide, sulfur dixode then ozone, and sulfur dioxide than ozone, and then sulfur dioxide. Concentrations of ozone and sulfur dioxide were, respectively, 0.15-0.28 ppm (on the average of 0.2 ppm) and 1 ppm. The single exposure period was 12 hr in the daytime. After the exposure, no visible injury was observed. The sulfur content of the leaves of exposed trees to SO2 decreased about 20-30%, and that of trees exposed to ozone before and after exposure to SO2 was the same as that of trees exposed only to SO2.
Source: 1

#973

Malo, B.A. and E.R. Purvis. "Soil absorption of atmospheric ammonia." Soil Sci., 97:242-247 (1964).

The NH_3 content of the atmosphere in New Jersey was found to vary from a trace to 0.22 mg/m^3, and to average 0.057 mg/m^3, in weekly determination made over a 12-month period. The average concentration found is approximately 3 times that accepted as normal. The NH_3-N content of precipitation at New Brunswick averaged 92 g per acre-inch, and totalled 8.2 pounds of N per acre, over a 12-month period. Soil absorption of NH_3 from the atmosphere was demonstrated in field, greenhouse, and gas chamber studies. Rates of absorption varied with soil type and ranged from approximately 23 to 91 g of NH_3-N per acre per day under field conditions. Nitrogen from this source is believed to have been a factor in the production of high corn yields without nitrogen fertilization in several New Jersey field trials from 1958-1960.
Source: 5

#604

Mamayev, S. A. "Nekotoryye itogi issledovaniy, provodyashchikhsya na urale po probleme Rastitel nost i promyshlennyye zagryazneniya." (Some results obtained in Ural in the problem of vegetation and industrial pollution). Text in Russian. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej konf. wplyw zanieczyszczen powietrza na lasy, 6th, Katowice, Poland, p. 249-256 (Sept. 9-14, 1968).

Studies on the resistance of ornamental plants and woody species of air pollution in the industrial areas of Ural are summarized. Sulfur dioxide, magnesitic dusts, hydrogen fluoride, and smoke were among the agents investigated for their noxious effects. These effects appearto be most severe in rainy days. The coniferous species appear to be the least resistant woody specimens to industrial pollutants. The physiologically less active woody species, with lower rates of photosynthesis and respiration, appear to be more resistant against sulfur dioxide. Approximately 50 kinds of waste emanations, which could be used as agricultural fertilizers, were determined. They were cathegorized under calcium, phosphorus, potassium, magnesium, and nitrogen containing wastes, organic wastes and microelement-containing wastes. Agrotechnical methods for soil treatment and plant care, as well as a selection of plants appropriate for the conditions existent in the industrial areas of Central and Southern Ural,have been worked out.
Source: 1

#829

Mamayev, S.A. "Current conditions and scientific problems in studying the injurious effects of industrial pollutants on plants and in developing methods for controlling them in the Urals." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature, Vol. III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union, M.Y. Nuttonson (ed.), Silver Spring, Md., American Inst. of Crop Ecology, p. 23-32 (1970).

The deleterious effects of gaseous pollutants and dusts on vegetation are discussed with special reference to the increasing industrialization of the Urals. While studies have been carried out in the region on gas resistance in plants and on the effect of dust pollution in wood plants, they have been fragmentary and the problem of plant protection remains unsolved. Development of plants resistant to air pollution will require the following: formulation of a general theory of gas and dust resistance in plants; investigation of soil formation and plant cover of dumps, ash piles, excavation waste, disturbed ground, and fills; investigation of plant nutrition under conditions of increased salt content and of changed water and air conditons; elaboration of plant and plant group classification under conditions of heavy air and soil pollution; methods of evaluating air and soil pollution in relation to the suitability of the polluted environment for growing various species of plants; and investigation of industrial pollution on microorganisms and fauna in verdant plantings of surburban belts as related to possible changes in the biocoenosis.
Source: 1

#30
Mamayev, S. A., and V. S. Nikolaevskiy. "Some peculiarities of the susceptibility of scotch pine sprouts to SO_2 injury." 6 pp. (1970). (No publisher).

Authors investigate certain aspects of plant variability in degree of gas resistance. Studied gasification effects on recently germinated pine sprouts, and measured degree of injury. No units for initial gas concentration are given. They found no definite correlation between the morphophysiological characteristics of the pine tree, its seed, and susceptibility of sprouts to gas injury. A great variability was observed. Authors assume that degree of development of plant is a factor. Larger plants were generally more resistant to SO_2. Pigmentation of cotyledon was affected. Water availability affected degree of damage.
Source: 8

#1537
Mamayev, S.A, and O.D. Shkarlet. "Effects of air and soil pollution by industrial waste on the fructification of scotch pine in the Urals." (Presented at the International Symposium of Forest Fume Damage Experts, Essen, West Germany, Sept. 7-11, 1970.) Mitt Forst. Bundesvers, 97:443-450 (1972).

The effects of industrial smoke and gases on the seedling intensity and quality in pine forests near copper smelting plants in the Urals were studied. The elevated sulfur dioxide content in the atmosphere significantly weakened the Scotch pine stands, thereby lowering the reproductive capacity of the trees. The seed number in the cones decreased, and the ratio of male to female cones and trees changed in favor of the females. The generative organ size of the trees in the smoke-damaged areas also decreased. This was most notable in terms of the ripe cone weight and the staminate cone size. The size of the seeds and pollen grains was characterized by the higher stability grade. The quality of the seeds and pollen grains from trees growing in the smoke-damaged areas was significantly worse than that of the pollen and seeds from trees in non-damaged stands. No specific effects of the smoke damage were observed, with the effects of the smoke on seed and pollen quality being similar to those of natural unfavorable factors.
Source: 1

#1265
Manganelli, R. M., and F. P. Terraglio. "Absorption of atmospheric sulfur dioxide by water solutions, protein solutions, and soils." (Terminal Progress Rept. May 1, 1962-April 30, 1966). Rutgers Univs., New Brunswick, N.J., Dept. of Environmental Sciences, 158 pp. (1966).

A laboratory study was conducted to determine the rate and extent of absorption of atmospheric SO_2 by thin films of water solutions. The adsorption by two types of soil also was measured. Water solutions were exposed in an environmental test chamber to atmospheric concentrations of SO_2 ranging from

0.5 to 10.0 mg., SO_2/cu m. Exposure periods varied up to 8 hours. It was found that over 98.5% of the SO_2 in the dilute solutions tested existed as the bisulfite and the rest was present as un-ionized H_2SO_3 acid. The solubility of the unionized H_2SO_3 was found to follow the law of partial pressures. Solutions of albumin, fibrinogen, globulin, and hemoglobin were exposed to atmospheric SO_2. Transformation of hemoglobin occurred as evidenced by a decrease in the absorbance of a solution read at 625 millimicrons. The reactions noted with protein solutions exposed to atmospheric SO_2 were duplicated with H_2SO_4 and did not represent specific chemical reactions of SO_2 with the proteins. It was found that pH and moisture were significant factors in the adsorption of atmospheric SO_2 by soils. In near dry conditions Lakewood soil (pH 4.0) did not retain any SO_2 when 600 liters containing 7.27 mg. SO_2/cu m was passed through 25 grams of the soil. On the other hand Nixon soil (pH 5.5) in near dry condition retained 1.13 milligrams of SO_2 from 600 liters of air containing 6.03 mg. SO_2/cu m. When the soil moisture was increased to 10 percent, the amount retained increased to 0.57 milligrams for the Lakewood soil and 2.91 milligrams for the Nixon soil.
Source: 1

#1538
Mann, C.W. "Plants contaminated by timber treatment." Environ. Health, 80(10): 360 (Oct 1972).

The foliage of plants in gardens in the immediate vicinity of a timber treatment plant appeared to be dying off in the Chailey Rural District, Sussex, England. The sample consisting of the foliage of bean, potato, cabbage, and parsnip had been damaged to various degrees. Rusty brown spots on all the leaves were observed and the bean leaves were completely dead. Insects attached to the plants were dead or dying with the appearance of having been burned. The analysis of the bean plant showed 286 ppm of chromium, 378 ppm of copper, and 596 ppm of arsenic. These plants had been severely contaminated with Tanalith C, and any food contaminated with these amounts of chemicals would be very dangerous and possibly poisonous. Further, samples of fruit including pears, blackberries, and strawberries showed similar contamination which varied according to the distance from the timber plant treatment. It appears that contamination has probably occurred primarily from the actual powder used for making the preserving solution being blown about immediately prior to mixing, from the contaminated dust in the yard where the timber drips after impregnation also being blown about, and from some solution and/or spray from the exhauster drifting onto the adjoining land.
Source: 1

#1540

Manning, W. J. "Effects of limestone dust on leaf condition, foliar disease incidence, and leaf surface microflora of native plants." Environ. Pollut., 2(4):69-76 (July 1971).

The effects of continuous emissions of limestone dust from quarries and processing plants on leaf condition, foliar disease acidence, and leaf surface microflora of native wild grapes, sassafras, and hemlock in a mountain valley in southwestern Virginia were investigated. Grape and sassafras leaves with moderate dust deposits had more fungal leaf spots than comparable leaves with visible dust deposits. Dusty grape and sassafras leaves were darker green in color than leaves with dust deposits, but all were comparable in size. The terminal new growth of hemlocks with heavy dust deposits was greatly reduced in length when compared to terminal growth on hemlock trees without visible dust deposits. Second year needles of dusty hemlocks were frequently chlorotic. Dusty grape and sassafras leaves had greatly increased numbers, but not kinds of bacteria and fungi when compared to clean leaves. Bacteria are greatly reduced in number on dusty hemlock leaves, while fungi were increased. Streptomyces spp. were few in number and were isolated almost exclusively from dusty leaves. Streptomyces spp. were absent, and bacteria and fungi were drastically reduced in kind and number on grape leaves heavily encrusted with dust.
Source: 1

#605

Manning, W.J., W.A. Feder, P.M. Papia, and I. Perkins. "Influence of foliar ozone injury on root development and root surface fungi of pinto bean plants." Environ. Pollut., 1:305-312 (April 1971).

Chronic exposure of Pinto bean plants to levels of ozone sufficient to cause foliar injury adversely affected shoot and root growth and vigor and enhanced senescence. These effects were reflected in quantitative rather than qualitative differences in the successional root surface fungi. More fungal colonies were consistently isolated from roots and hypocotyls of plants exposed to O_3 than from those grown in charcoal filtered air. Roots and hypocotyls of plants exposed and not exposed to O_3 were colonized by the same fungi and each had the same general mycoflora at each sampling period. Rhizobium nodules were found on the roots of plants grown in charcoal filtered air, but were not found on the roots of plants grown in the O_3 chamber.
Source: 1

#1539
Manning, W.J., W.A. Feder, and P.M. Vardaro. "Reduction of chronic ozone injury on poinsettia by benomyl." Can. J. Plant Sci. (Ottawa). 53:833-835 (Oct. 1973).

Poinsettia plants (Euphorbia pulcherrima Wild.) were repeatedly exposed to ozone at 0.10 microliter/l (10 pphm) for 8 hr/day, 5 days/wk, for 68 days and compared with plants grown in ozone-free charcoal-filtered air. The fungicide Benomyl (methyl-1- (butylcarbamoyl)-2-benzimadazole carbamate) was then applied as a soil drench to plants in both air regimes at 0, 500, and 1000 micrograms/ml at 3, 30 and 57 days after initiation the experiment. Untreated plants of both cultivars exposed to O_3 developed symptoms of chronic O_3 injury expressed as chlorosis and senescence of lower leaves decreases in stem diameter, and fresh and dry weights of stems and leaves. Benomyl soil drenches, at both rates, significantly reduced incidence of chronic O_3 injury on both cultivars.
Source: 1

#830
Mansfield, T. A., and O. Majernik. "Can stomata play a part in protecting plants against air pollutants." Environ Pollut., 1:149-154 (1970).

The stomatal closing reaction to carbon dioxide seems to be of wide occurrence among plant species, though the magnitude of the effect does vary and the stomata of some crops, such as tomato and cotton seems to be relatively insensitive to CO_2. Usually, however, the stomata begin to close when the CO_2 concentration rises slightly above the normal 300 ppm, and open widely when it falls below this figure. The concentration of CO_2 also tends to increase as the concentration of other pollutants increases; the stomatal closure in response to CO_2 should offer the plant some protection against the dangerous pollutants. With a suitable selection program, it is reasonable to suppose that crop varieties could be produced with enhanced stomatal responses to CO_2. Studies with broad bean have revealed two kinds of stomatal reaction to sulfur dioxide, which depend on the relative humidity of the atmosphere. The effect which is probably of most significance occurs when the relative humidity is greater than 40% at 18 C; it involves an opening of the stomata to much wider apertures than normal. An important question to be answered in future research is whether there is any possibility of preventing such abnormal opening of stomata.
Source: 1, 6

#606
Marchesani, V.J. "A study of the effect of air pollution on fungus." Atmos. Environ., 3(6):685 (Nov. 1969).

The fact that air pollution appears to cause an inhibition in plant and fungal growth is of major significance because under controlled conditions the amount of dry weight fungal growth should be related to the amount of air pollution in the atmosphere. Four pairs of glass tubes equally spaced in a manifold arrangement contained at the end of each tube a filter, a

manometer, and an impinger. Each pair of the four pairs of impingers was used as a separate experiment involving a control and an experimental sample. The filter on the control side of the manifold was packed with activated charcoal and glass wool, and Othe filter on the experimental side of the manifold was packed with only glass wool. Each experimental pair of impingers containing a nutrient solution was inoculated with a different type of fungus. An hourly average of the pollutants measured by the Philadelphia Continuous Air Monitoring Program were received and correlated with differences in growth, on a dry weight basis, between the controls and experimental samples. One experiment demonstrated definite growth differences which could be correlated with high levels of nitric oxide.
Source: 1

#972
Marchesani, V. J., T. Towers, and H. C.Wahlers. "Minor sources of air pollutant emissions." J. Air Poll. Control Assoc., 20:19-22 (1970).

It has been shown that minor sources of air pollutants normally not included in an emission inventory do contribute to the total pollution burden of an area. In areas where particulate emissions are important, natural sources of dust, cigarette smoking, cigar smoking, spray can aerosols, foot wear use, and rubber from tire abrasion should be evaluated. In areas where photochemical air pollution is a major problem organic compounds from vegetation must be considered in the evaluation of the problem.

Great strides have been made in the development of factors to be used in the calculation of air pollutant source emission inventories. It is suggested that emphasis should be also directed toward a more extensive study of minor sources of other pollutant emissions.
Source: 5

#1932
Margot, J. "Experimental Study of the Effects of Sulphur Dioxide on the Sordia of Hypogymnia Physodes." In: Air Pollution and Lichens, B.W. Ferry, M.S. Baddeley, and D.L. Hawksworth (eds.), Toronto Univ. Press, Toronto , Chapt. 15, p. 314-329 (1973).

The effects of sulfur dioxide on the soredia of Hypogymnia physodes were investigated. The lichens were injured with gaseous SO_2 in concentrations of 0.05, 0.1, and 1.0 ppm and sprayed with concentrations of 0.5, 0.75, and 1.5 meg/100 ml of ammonium sulfate in solution. In both cases the pollutant affected the lichen and its soredia according to the concentration of the pollutant, the frequency and number of injections, and the length of the conditioning time. A maximum effect for a given treatment is reached at some point, and the pollutant is more harmful in conditions of high relative humidity. This method is applicable to different species and in mapping studies of air pollution.
Source: 1

#607
Markland, J. and J. Vallance. "Investigation of the uptake of lead by vegetables from composts containing lead." (Presented at the Association of Public Analysts, Annual Conf., Matlock, England, May 13-15, 1971). J. Ass. Pub. Anal., 9:119-121 (Dec. 1971).

Areas of Derbyshire near the sites of former lead mining operations have lead in the soil. The lead present in plants grown in the area could have been derived from air pollution or from the soil. An investigation was undertaken to determine the amount of lead in vegetables grown in soil with controlled lead content. John Innes No. 3 compost without calcium carbonate was used as an acid soil and the same compost with calcium carbonate as a neutral soil. The composts contained 50 parts of lead/million. Each compost was divided into four lots and the lots were dosed with lead carbonate to give added lead contents of 0, 250, 500, and 1000 ppm. Carrots, peas, French beans, lettuce, cabbage, and brussels were grown in these composts, out of doors. Samples were digested by the nitric acid/sulfuric acid process, followed by dithizone extraction and colorimetric or polarographic estimation of lead. There was only a little evidence of lead uptake for peas and no evidence of lead content increasing with the lead content of the compost. The lead on the French beans increased with the lead content of the compost. Soil contamination by air pollution occurred with the carrots, lettuce, and the brussels samples.
Source: 1

#1541
Marletta, G.P., L.F. Gabrielli, and L. Favretto. "Lead in grapes exposed to automobile exhaust gases." J. Sci. Food Agr., 24(2):249-252 (Feb. 1973).

Lead accumulation in grapes from vineyards exposed to lead contamination due to their proximity to roads carrying heavy traffic was investigated. Lead accumulation in the grapes exposed to exhaust gases decreased parabolically with the logarithm of the distance from the source of pollution. The maximum extrapolated value was 4.6 micrograms/g of dried grapes, i.e. 10 times the normal content. The pollution index decreased to zero at 100-200 m away from the road.
Source: 1

#1144
Marshall, L. "Tree canopy values in a resort community." Landscape Archit., 62 (2):144-145 (1972).

The Clearwater Study formulates an implementation program as part of the planning process to preserve, protect, and enhance the defined ecological value. The values of trees is seldom set by commercial standards. The Clearwater Study documented the relationship between trees and environmental protection. (note -the article is simply a review of the Clearwater Study)
Source: 5

#223
Marten, G. C., and P. B. Hammond. "Lead uptake by bromegrass from contaminated soils." Agron. J., 58(5):553-554 (Sept-Oct 1966).

The possible absorption of concentrations of lead toxic to animals into the foliage of bromegrass growing in contaminated soils from specified sources was studied. Plants propagated from the same clone of bromegrass at an experimental farm were defoliated and transplanted to four soils in pots. The sandy-loam soils were from the surface, 25 mm from a farm adjoining a battery smelter (680 ppm lead); the surface, 25 mm from the bank of a well-traveled, 4-lane highway (59 ppm lead); from the normal greenhouse supply, (12 ppm lead); and a 25 mm layer at a 150 mm depth from a farm (95 ppm lead). Three crops were harvested from each pot. When the crops reached the heading stage (after 69 days) the first crop was harvested. The second crop was harvested after 73 days regrowth without heading. Chelates were added to the soils after the harvest of the second crop. The third crop was harvested at the heading stage after 37 days regrowth. Only the highly contaminated surface soil obtained from the smelter area (soil A) produced first-crop grass with significantly more lead than the control. No statistically significant differences appeared in the second crop, but there was a trend toward higher lead in soil A. The addition of chelates resulted in a distinct increase in lead concentration in grass growing in the two most contaminated soils. Trends toward greater lead uptake also appeared in the control and highway bank soils. Even the greatest lead grass concentration (34.5 ppm) was far below the level which would be toxic to animals consuming grass. At least 150 ppm lead in the total ration of dry matter is needed to approach levels to be toxic to cattle and horses.
Source: 1

#386
Martens, D.C., and C.O. Plank. "Basic soil benefits from ash utilization." (Presented at the International Ash Utilization Symposium, 3rd, Pittsburgh, Pa., March 13-14, 1973.) Bureau of Mines Information Circ., 8640: 269-279 (1974).

Laboratory, greenhouse, and field investigation were conducted to identify beneficial effects of fly ash applications on plant growth and to determine levels of fly ash applications that allow normal plant growth. The greenhouse studies showed that application of selected samples of fly ash to soil increased the plant availability of soil boron, molybdenum, phosphorus, potassium, and zinc. Application of fly ash from the Big Sandy and Fort Martin plants increased yields of alfalfa grown in the field on Tatum silt loam. The yield increases were attributed to correction of boron deficiency. Application of fly ash from the Clinch River plant increased yield of alfalfa grown in the field on an acidic Cecil fine sandy loam. The yield increase was attributed to the increase in soil pH from fly ash application. The sample of fly ash under study neutralized 1.23 milliequivalents hydronium ion/g, which is relatively high compared with other samples of fly ash from bituminous coals. Two annual applications of 64 tons/acre of Glen Lyn fly ash did not adversely affect corp plants grown in the field on Davidson clay loam and Groseciose silt loam. The fly ash under study had weathered in a lagoon prior to use in the field experiments. Results of these studies in-

dicated that relatively high amounts of weathered fly ash may be disposed of in agricultural soils. Two annual applications of 48 or 64 tons/acre of the weathered fly ash increased yield of corn grown in the field on Woodstown loamy fine sand. The specific reason for the yield increase was not identified. The fly ash may have increased yields by increasing the amount of available boron or calcium in the soil, by increasing the pH of the soil, or by increasing the content of moisture in the soil.
Source: 1

#130
Martin, A., and F. R. Barber. "Some measurements of loss of atmospheric SO_2 near foliage." Atmospheric Environment, 5:345-352 (1971).

Measurements of atmospheric sulphur dioxide made close to a hedge have given low results. Continuous simultaneous measurements made close to and well above the hedge have enabled hourly losses to be assessed. The effects of rain, dew, temperature, humidity, steady concentrations and fumigations are discussed. The greatest losses were (a) in the rain or dew, by surface adsorption, especially at night and (b) in the daytime, when the open air was fairly warm and gaseous assimilation through the leaves occurred.
Source: 6, 7

#1542
Martin. W., and T. Keller. "Ueber den Einfluss verunreinigter Stadtluft auf die Vegetation." (On the influence of polluted city air on the vegetation). Text in German. Umwelthygiene, 25(10):221-227 (1974).

Ash trees and spruce were planted into styropor pots and setup on roof gardens throughout Zurich in early April 1972. It was hoped that metabolic changes due to the effect of air pollutants could be detected by determination of the peroxidase activity. For this, leaf and needle samples were taken on June 7 (8½ week after the initial exposure), July 3 (after 12 wk), July 24 (after 15 wk) and August 14 (after 18 wk). The samples were deep frozen and stored for the analysis. Peroxidase activity was determined by the colorimetric method described by Keller and Schwager. Peroxidase activity of the exposed ash trees increased markedly. It was highest in that part of the city with the highest air pollution. It is assumed that part of the city with the highest air pollution. It is assumed that the traffic exhaust gases, particularly ethylene and ozone, are responsible for the increased peroxidase activity. Nitrose gases, too, could be responsible.
Source: 1

#727
Marx, J. L. "Air pollution: effects on plants." Science, 187(4178): 731-733 (February 28 1975).

Describes the variables known to effect the extent of injury to plants. Leaves are usually the site of injury by gaseous pollutants. Ozone may act by oxidizing sulfhydryl groups or by oxidizing lipids. With electrolyte and nutrient balances disturbed, the cells collapse and die. NO_2 and PAN both injure plants, but PAN is far more toxic. Oxidants may reach higher concentrations downwind from cities because reactions for the build-up of ozone are slow. Most investigations have been concerned with acute exposures to one pollutant, but there is evidence that mixtures of pollutants have a synergistic effect, rather than just additive. Some experiments have shown that mixtures of SO_2 and O_3 may produce synegistic, antagonistic or merely additive effects.
Source: 2

#608
Masek, V. "Neue Erkenntnisse ueber die Eigenschaften des Flugstaubes aus der Kokerei. Einfluss auf biologische Prozesse der Pflanzen." (New findings covering the properties of fly dust from coking plants. Influence on the biological processes of the plant). Text in German. Wasser, Luft Betrieb, 15(11):417-421 (Nov. 1971).

The hydrolysis of starch with amylasis in the presence of fly dust samples from coking plants as well as the hydrolysis of albumen with pepsin at 37C was studied. Three different fly dust samples were used containing 15.12, 13.14, and 14.56% by weight ash; 22.05, 12.19, and 4.16% volatile substance; 10, 168 and 6 micrograms soot/g dust; and 3, 98, and 2 micrograms benzo (3-4) pyrene/dust. The fraction of particles below 5 micron was 6.6, 1.4, and 3.1% by weight; between 5 and 10 micron, 32.5, 6.5, and 20.4%, and between 10 and 50 micron, 58.1, 16.1, and 57.2% by weight. The influence of these dust samples on the enzymatic reactions was studied by inversion of saccharosis with invertasis in a buffered environment. None of the three dust samples influenced the enzymatic reactions. The influence of these fly dust samples on the intensity of photosynthesis of young bean plants immediately after the appearance of the first leaves was also studied. By comparison with a plant grown under optimum conditions, it was found that the dust reduces the chlorophyll content. The fine grain dust adheres to the leaves so that the grain size fraction is of major importance. Only very little of the nutritive substances of the dust samples were taken in by the plants. The total growth speed was hardly influenced by the dust samples. The toxicity of the aqueous dust extract was tested by determination of the germination index and the root growth. All three dust samples were toxic.
Source: 1

#609
Masek, Vaclav. "Der Einfluss des Flugstaubes aus der Kikerei auf einige biologische Prozesse de Pflanzen." (The influence of fly dust from coking plants on some biological processes of plants). Gesundh. Ing., 93(3): 77-80 (March 1972).

The influence of three typical samples of fly dust from a coking plant on enzymatic reactions, photosynthesis, chlorophyll concentration in leaves of bean plants was studied. The hydrolysis of starch with amylasis and of the albumen with pepsin at 37 C and the inversion of sacharosis by invertase in a buffered environment were also examined. None of the three dust samples showed a significant activity in enzymatic reactions. Applying the dust samples to the leaves of young bean plants reduced the intensity of photosynthesis and the chlorophyll concentration. In aqueous extracts, the dust samples liberated only small quantities of nutrients. Plants which were grown in a dust suspension showed no increase of dry substance and growth rate. A stimulating effect of the dust samples on root growth was determined. A mixing of the dust samples with the soil influenced the accessibility of water to plants.
Source: 1

#1945
Massey, A., and J. Robinson. "A review of the factors limiting the growth of nuisance algae." Water and Sewage Works, pp. 352-355. (No date).

The way to slow cultural eutrophication is to stop input into waterways of the key factor in algae growth. Discovery of that factor, however, is complicated, because the aquatic ecosystem is a multifactor system in dynamic equilibrium, the equilibrium established by the particular geochemical character and biota of the lake. The isolation of a single limiting factor from various lake types has proven a difficult and confusing task.
Source: 5

#610
Massey, L.M. "Similarities between disease symptoms and chemically induced injury to plants." Air Pollution, Proc. U.S. Tech. Conf., Washington, D.C., p. 48-52 (May 3-5, 1950).

Plant effects induced by sulfur dioxide and hydrogen fluoride are used to illustrate the difficulties in diagnosing cases of suspected injury from phytoxic gases. Disease (i.e.,injury) caused by such chemical is a continuing process parelleling disease caused by living organisms, with chemical analysis of plant tissue used instead of microscopic examination and culture of the living organism to identify and confirm the diagnosis. Despite extensive knowledge of the characteristic symptoms produced by SO2, field diagnosis is often complicated by the wide variety of markings caused by such factors as drought, frost, winter injury, insects, disease, and various physiologic disorders. Thus, some knowledge of the conditions of exposure, weather factors, and the reaction of susceptible indicator plants is necessary. Sulfur dioxide and hydrogen fluoride produce symptoms that are similar in certain respects and difficult to distinguish. Problems in using color values, tip burn, and foliage injury to conifers as diagnostic symptoms are discussed.
Source: 1

#728
Mastalerz, J. W., and C. S. Oliver. "Microclimatic modification: development and application in the urban environment. The use of plants to modify temperatures, noise levels, and air pollutants." Hortsci., 9(6):560-563 (December 1974).

Examinations as to how plants can be used to modify air temperature, noise levels, and pollutants. Description of climatic features of the city as they differ from the natural ecosystem. Man-made changes are responsible for these differences. Plants may reduce some human stresses, but plants, in an urban environment, have increasing amounts of stress put upon them. Concepts of greenbelts near urban centers, must occupy further consideration. Horticulturists must concern themselves with growing plants which are adaptable to urban stresses.
Source: 2

#1543
Masuch, G., H. Weinert, and R. Guderian. "Wirkungen von Chlorwasserstoff und Schwefeldioxid auf the Ultrastruktur der Chloroplasten und Schwefeldioxid auf the Ultrastruktur der Chloroplasten von Spinacia oleracea L." (Effects of hydrochloric and sulfur dioxide on the fine structure of the chloroplasts in Spinacia oleracea L.). Text in German. Proc. Int. Clean Air Congr., 3rd, Duesseldorf, West Germany, p. A160-A163 (1973).

The effects of various concentrations of hydrochloric acid and sulfur dioxide in the air on the appearance, and on the ultrastructure of the chloroplasts of Spinacia oleracea L. were studied. Exposure to HCl concentration of 0.13 mg/cu m for 43 hr in 5 days caused no visible symptoms of leaf damage while slight necrosis and chlorosis of the leaves of plants exposed to a HCl concentration of 1.6 mg/cu m for 208 hr in 2 weeks were observed. Microscopic investigations of such leaves revealed an increase in the average frequency of grana per unit stroma surface, and swelling of the thylakoides. Rather uniform organization of the grana, acceleration of the grana formation, both proliferation and enlargement of the osmophilic plastoglobuli, and reduction in the mean frequency of starch granula within the chloroplasts were observed in leaves exposed to HCl concentrations of 0.025 and 0.13 mg/cu m. Sulfur dioxide in a concentration of 1 mg/cu m necrotized 1% of the total leaf surface in 23 hr. An increase in the average frequency of the grana per unit cross section area, increase in the amount of plastoglobuli by more than 100%, cumulation of osmophilic ganula at the edges of the grana thylakoides, and the presence of granular, osmophilic substances in the loculi of the grana thyladkoides were observed in leaves previously exposed to SO_2. Clear distinction was made between the degenerative changes produced by HCl and SO_2; the HCl induced increase in the volume and number of plastoglobuli is similar to the natural aging process, while SO_2 causes accumulation of granular, osmophilic substances in the loculi and canal of the thyladkoides.
Source: 1

#574

Masui, K. "Hochi dekinu taikichu no sanso ketsuzo." (Lack of oxygen in the atmosphere becoming serious). In: Noyakugai to sono taisaku ni tsuite (Pollution Due to Agricultural Chemicals and its Countermeasure), Research Institute for Cooperative Management, Tokyo, pp. 124-128 (1971).

Since the amount of carbon dioxide created by the combustion of natural resources at present is 25% of the total amount in the air and is predicted to increase to 60% in 30 years and to double the amount of natural CO2 in the air in 40 years, the Ministry of Forestry has initiated a project to not only prevent air pollution but also increase the supply of oxygen by plants (vegetation) and actively purify the air. A budget of $560,000,000 was requested as a first step toward an investigation to accurately measure the oxygen supply by vegetation. This Gross Forest Products investigation includes the usual conservation program and protection of wildlife, the development of a method of measuring oxygen supply, and the local application of this method in five to 17 forest areas for the next three years. At present, no data exist for this project. A similar project on an international scale (called IBP, or International Botanical Project) has been in progress since 1965 as an eight-year-plan; however, it emphasizes the study of nature's mechanism for environmental balance. The amount of oxygen supply by trees is larger than that by grass; under ideal conditions, one gram of needle-leaf absorbs 2-3 mg of CO2; evergreen absorbs 2-4 mg; and deciduous trees, 6-10 mg. Oxygen is created at the rate of 70% of the amount of CO2 absorbed by respective trees; while one hectare field of wheat absorbs 15 tons of CO2 and creates 10 tons of oxygen in a year.
Source: 1

#1544

Materna, J. "Einfluss des Schwefeldioxyds auf die mineralische Zusammensetzung der Fichtennadeln. (The influence of sulfur dioxide on the mineral composition of needles from spruces). Translated from German. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, 3 p., Oct. 22, 1969. Naturwissenschaften (Berlin), 48(23):723-724 (1961).

The question of whether mineral substances other than sulfur, silicic acid, and iron accumulate in the assimilating organs of smoke injured plants, particularly cations such as calcium, potassium, and magnesium is analzyed. Since analyses of injured needles alone cannot provide definite results, gassing tests with older spruces were performed. Two twigs packed into polyethylene bags; one was gassed with air and sulfur dioxide, the other with pure air. Not only did the gassing increase the sulfur content, but also that of Ca and Mg; it caused a considerable increase of water soluble magnesium. A second gassing experiment was performed which yielded no difference in the concentrations of Ca and Mg, but a markedly higher potassium content was found.
Source: 1

#1212

Materna , J. "Auswertung von Düngungsversuchen in rauchgeschädigten Fichtenbeständen." (Fertilizer effects on smoke damaged pine trees). Wiss. Z. Techn. Univers. Dresden (Herausgeber: Der Rektor), 11(3):589-593 (1962).

Fertilizing in smoke affected pine stands is used to improve the soil, expecting to improve the nutritional conditions for the trees and possibly to raise their smoke resistance at the same time. The use of lime in smoke affected stands has proven not to be necessary. The cations brought into the ground by precipitation are completely sufficient to neutralize the anions of the sulfuric acid resulting from air pollution. It was found that with an increase of sulfur ions in needles fumigated with SO_2, the average amounts of calcium, potassium, and magnesium also increased. However, it is still unresolved how the use of specific nutrients could influence the air pollution resistance of trees. Tests using rock dust, lime, nitrogen, and phosphoric acid in smoke affected stands brought an increase in growth, without resulting in an increased smoke resistance.
Source: 6

#1545

Materna, J. "Moznosti prukazu skod pushobenych prumyslovymi exhalaty v lesnich porotesch." (Ways of determing damages to forest stands caused by industrial air pollution). Text in Czech. Les. Pr., 43(5):212-216 (May 1964).

Solid pollutants affect trees indirectly, mainly by adhering to the leaves and thus depriving them of the benefits of the sunlight. They are, however, less injurious than the gaseous pollutants. The worst offender among these is sulfur dioxide because it is so widespread; the effects of chlorides and fluorides are equally as bad, although these elements do not occur as frequently in the atmosphere. Nitrogen oxides are injurious only in the immediate vicinity of the source. Conifers are seriously affected by sulfur dioxide; their needles are discolored, become dry and drop off. Older growth is affected first. Spruce shows serious damage after prolonged exposure to as little as 0.5 mg silicon dioxide/cy m air. Fir and larch are also very sensitive; pine is less sensitive. Broad-leaved trees are far more resistant to high pollutant concentrations which cause necrosis on the periphery of the leaf and gradually extend to the interior under prolonged attack. Diagnostic methods include determination of the pollutant concentration in the foliage and in the soil. An important factor is the chlorophyll content; SO_2 reduces its overall content, and changes the ratio a:b chlorophyll. The affected foliage contains also pheophytin, which is formed by magnesium abstraction from chlorophyll. In the case of conifers, a quantitative diagnostic tool is the Haertel test (hot water extraction of the needles, measuring of the turbidity of the extract). Another simple test is the sun test in which twigs are cut off and exposed to sunlight. Twigs from trees affected by SO_2 dry much faster than twigs from healthy trees.
Source: 1

#611
Materna, Jan. "Prumyslove exhalace a lesni hospodarstvi." (Industrial air pollution and forestry). Les. Pr., 45(10):433-439 (1966).

A most prominent air pollutant affecting forestry is sulfur dioxide, generated primarily by power stations which use fuel of fossil origin. Sulfur dioxide can cause damage to trees; it may take several years until the damage becomes apparent in its characteristic forms, such as falling off of older needles, loss of density of the crown, drying of branches in shadowy parts of the tree, drop in overall vitality, and the eventual death of trees. Contrary to earlier assumptions which regarded a concentration of one mg SO2/cu m air as the minimum for bringing about such damage, more recent studies conducted in Bonemian areas have shown that,under long term conditions, a concentration of 0.1 mg SO2/cu m will be sufficient to cause visible damage to older trees. Experiments with induced smoke emissions in tree nurseries have shown that under certain conditions such as warm weather and clear sunshine, acute damage to individual young trees was caused after a short time of exposure to an SO2 concentration of about one mg/cu m of air, characterized by a change of color of the needles. Under normal circumstances, a 5 to 10 mg/cu m concentration of SO2 acting upon young pine trees can bring about distinct change, characterized by a rapid change of needle color to red and dying off the youngest needles. The youngest leaves show maximum damage in decidious trees under similar circumstances. Economically, the acute effects are of much less importance than the chronic damage caused by long term low concentrations of the pollutant. Forestry can combat these conditions to some extent by cultivating more resistant species and by regular removal of dead and underdeveloped trees. Fertilizing also contributes to increased resistivity. However, ways of reducing the quantities of pollutants emitted into the atmosphere should be found.
Source: 1

#831
Materna, Jan. "Nektere vysledky vyzkuma v krusnohorske kourove oblasti." (Partial results of research in the smoke region of the Krusne Hory mountain range). 19 p. (Jan 1970). (No publisher).

Following the rapid advance of damage by smoke emissions to forest flora in the eastern section of the Krusne Hory mountain range, sulfur dioxide measurements were taken in the most affected areas. Where sulfur dioxide was present, the average concentration was one mg per cu m of air. The influence of precipitation on this concentration is considerable, as is that of fog and to a lesser extent, wind direction. The measured SO2 concentrations are high enough to cause a decreased production and damage to plant life. They respond to calculated and measured values of sulfur content in the assimilative organs of injured plants. Further research indicated that fertilizer will increase the resistance of assimilative organs of the plants and promote new growth, even of trees highly sensitive to SO2. Related investigations pertained to the possibility of using forest flora, especially spruce, to indicate the action smoke gases and their presence in the atmosphere and to the significance of forest flora for cleaning air in industrial regions. Based

on measurements of sulfur in needles and the turbidity of water in the tracts of needles, it is concluded that spruce is suitable for proving the influence and content of smoke emissions. Forest flora are shown to have only a negligible role in air purification near large enterprises. On the other hand, the ability to absorb sulfur dioxide is great enough for them to have a prominent role in purification where sulfur dioxide levels do not exceed 0.2 mg per cu m of air.
Source: 1

#1546

Materna, Jan. "Einfluss niedriger Schwefeldioxydkonzentrationen auf die Fichte." (Effect of low sulfur dioxide concentrations on the fir). Mitt. Forst. Bundesvers, 97:219-232 (1972).

The effect of low concentrations of sulfur dioxide on fir trees was studied in a long-term experiment. The effects of SO2 were checked through both external features and chemical analyses of needles. The plants were exposed to less than 1 mg SO2/cu m air, with most concentrations below 0.5 mg SO2/cu m. Sulfur dioxide was continuously monitored and needles were sampled irregularly and analyzed for potassium, calcium, magnesium, phosphorus, glucose, fructose, surcrose, starch, vitamin C, and chlorophyll a and b. The firs were gassed for almost 2000 hours during 6 years. The gassing caused a significant increase in the sulfur level in needles, and produced an increase in K, Ca, and partially in Mg and P. In some cases, an increase in the total amino acid content and a reduction in the content of starch, glucose, sucrose, vitamin C, and chlorophyll a and b occurred. There was an unfavorable effect on the growth in height of the gassed firs. Actual external injury was established clearly in only one case.
Source: 1

#29

Materna, J., and R. Kohout. "The absorption of sulphur dioxide by spruce and pine trees." Naturwissenschaften (Berlin), 50(11):407 (1963).

During an investigation of the composition of spruce and pine needles in stands damaged by smoke, the sulfur content of the needles increased in the winter. Part of this accumulation can be explained by the weight loss that occurs in winter and the relative accumulation of the content material that this causes; in heavily damaged trees the increase is so large that this explanation is insufficient. Investigations were conducted to determine if sulfur dioxide was assimilated by the needles during winter. Marked sulfur dioxide, SO_2(35), was used for this purpose. In 15 to 25 year old, healthy, free-standing spruce and pine trees, a well developed branch was wrapped in a polyethylene bag. An ampule of SO_2 was crushed in the bag producing a concentration of 8-10 mg SO_2/cu m of air. Needle samples were taken after 24 hours and at regular intervals. The results showed that the needles of the treated branch absorbed almost the entire quantity of SO_2. A small amount of the sulfur was transported to ungassed needles in other parts of the crown, but it was intensively stored in needles of newly formed shoots. Similar experiments showed that SO_2 also absorbed at night.
Source: 1

#1180

Materna, J., and R. Kohout. "Uptake of SO_2 into the leaves of some tree species." Communiciones Instituti Forest alsi Cechosloveniae, 6:39-47 (1969).

Results of the present investigation may be summarized as follows:

1. There is a distinctly greater absorption of sulphur dioxide by the marginal part of the leaves, in some cases also in conifers a greater absorption into the needle top can be observed.

2. An intensive uptake of sulphur dioxide also into the lenticelles and in some tree species into the whole surface of the bark takes place.

3. The intensive uptake of SO_2 into the bark and a distinct uptake in conifer needles in winter is presented on the autoradiograms.

Source: 6, 8

#1210

Materna, J., R. Kohout, and L. Ryska. "Absorption of SO_2 by spruce needles." Lesnictvi, 17:1065-1073 (1971)

Absorption of toxic matters from immissions froms a first stage of the process leading to plant injury. It is therefore desirable to study throughly the mechanism of absorption from this viewpoint, but it is also necessary to extend the theoretical bases of leaf analysis and to obtain the fundamental data on the possibility of the influence of immissions in winter, when higher SO_2 concentrations generally occur in the atmosphere.

The studies were therefore concentrated to the solution of following problems:

1. SO_2 absorption in winter. 2. Differences in SO_2 absorption by needles of different age and in different parts of the crown. 3. Translocation of sulfur compounds from SO_2 in the tree. 4. Individual variability in the extent of SO_2 absorption in Norway spruce.

The evidence of the absorption of sulfur dioxide by spruce needles in winter was given. SO_2 absorption in winter occurs intensively via bark, whereas in spring months sulfur from SO_2 is transferred to needles (fig. 1 and 2).

The differences in the absorption by needles of various age and in various tree crown parts were proved in the experiments both with $^{35}SO_2$ and with fumigation of non-radioactive gas (tab. II and III). Sulfur levels in various branch whorls of spruce in smoke area are obvious and have in the given case (tab. IV) statistical significance.

The transfers of sulfur were confirmed not only between individual parts of a branch, but also in the whole tree. Nevertheless, the sulfur movement was relatively small.

The individual differences in the absorption are very distinctive (fig. 3, tab. VI). Immediately in the smoke area it was possible to prove that the more resistant and less damaged trees absorbed evidently a lesser amount of $^{35}SO_2$.

Source: 6

#15

Mathe, P. "Die bedeutung von gruenraeumen und pflanzen in der stadt fuer die gesundheit des menschen." [The importance of green belts and plants in the city for the health of man]. Schriftenreihe Ver. Wasser, Boden-Lufthys, (Berlin), 38:285-298 (1972).

Green belts in cities are important for recreation, dust absorption, oxygen supply, and noise abatement. Green zones throughout the city improve the city climate which is usually marked by a lower relative humidity (in some cases up to 7% less than in surrounding rural areas), warmer temperatures (the annual average temperature in urban areas is higher by 0.5 to 1.5C, the daily average may be higher by 4 to 10 C), and higher absorption of solar radiation by haze and aerosols. Leaves and needles of evergreen plants absorb 10 to 30 mg dust/100 sq cm in three precipitation-free summer weeks; in three winter weeks with precipitation they absorb two to seven times as much. With densely planted green belts the maximum dust concentration is found on the windward side, with loosely planted green belts the maximum dust concentration is found right behind the belt. Repeated green belts in regular intervals of varying thickness are the most efficient dust traps. As for the filtering effect of gases such as carbon monoxide, and sulfur dioxide, 3-month measurement series was taken during the vegetation period 1970. The 50% values of the sum frequency of SO2 half-hourly-averages in urban and recreation zones were about the same, namely 60 and 66 micrograms SO2/cu m air. The 95% values were higher in urban zones (360) than in recreational green belts (250 micrograms/cu m). The 97.5% value was 465 micrograms SO2/cu m in urban zones and 318 micrograms in green belts.
Source: 1

#224

Matshushima, J. and M. Harada. "Kaju no aryusangasu niyoru engai (dai 2 ho) Higai kankitsuju no jittai narabini sono eiyokakuteki kansatsu." (Sulfur dioxide gas injury to fruit trees. II: Actual conditions of suffered citrus trees and survey of their nutritional status). Engei Gakkai Zasshi (Tokyo), 34(3):169-176 (1965).

The actual conditions and the results of leaf analysis of Satsuma orange trees exposed to smoke pollution are discussed. Most of the leaves showed symptoms of sulfur dioxide injury, and some showed signs of sulfuric acid mist injury. Some leaves fell rapidly without showing any diseased spots. No significant correlation was found between the soil pH and the SO2 concentration in the atmosphere. The sulfur content of the leaves was high, and it was highly correlated with the SO2 concentration in the air. The sulfur content increased with leaf age from July 1963 to January 1964. It's increasing rate was greatest when the SO2 gas flowed in the orchard. A high negative correlation existed between the sulfur and calcium contents of leaves, having the coefficient of -0.67. The potassium and manganese contents increased as the sulfur content increased, but no correlation was found. The composition of nutritional elements in Satsuma orange trees seems to be affected directly or indirectly by the SO2 concentration in the air.
Source: 1

#1435
Matsui, Koyo. "Kankyo hozen to shinrin shigyo." (Environmental protection and forest administration). Shigen (Resources), 188:71-76 (March 1974).

With the recent increase of air pollution, West Germany reports that forests receive 20-25 kg/ha of nitrogen with rain precipitation and 100 kg/ha of sulfur dioxide. About the same amount of nitrogen precipitates in Japan in areas near cities. Ammonia nitrogen is absorbed into soil as nitrogen trioxide; part of it is absorbed by plants and becomes nourishment, and part of it flows into streams and rivers. However, while passing through the forest soil, the concentrations of nitrogen or phosphorus or sulfur dioxide decrease, the forest soil working as a kind of filter. Therefore, forests have a cleansing mechanism for air and water, helping soil conservation in addition to producing timber. As one of the health effects of forests they stabilize carbon dioxide an emit oxygen. But since their own respiration consumes O_2 and emits CO_2, the actual amount of O_2 emission is the difference between the production and consumption. Old forests emit a relatively small amount of O_2. The trees, in addition, have some cleansing effects for pollutants by accumulating them on leaves acting as filters; however, this contribution is very limited and when the amount exceeds a certain level, the trees themselves will be harmed.
Source: 1

#1549
Matsumoto, Hiromi, Takashi Sumimoto, Shigehiko Matsumoto, and Nobuaki Izumo. "Kagoshima-ken no jidosha haikigasu ni yoru dojo no enosen chosa ni tsuite." (An investigation of lead-pollution of soil by automobile exhaust gases in Kagoshima-Prefecture). Kagoshima-ken Kogai Eisei Kenkyusoho (Rep. Kagoshima Prefect. Inst. Pollut. Pub. Health), 9:104-106 (Aug 1973).

The lead pollution by automobile exhaust gas is becoming a serious concern with the rapid increase in number of automobiles. At 20 measuring points set along the major highways and at intersections, the lead concentration which accumulated in the soil was measured. The upper layer (surface layer) and lower layer (layer at 10 cm from the ground surface) of soil were sampled over a period from April 1972 through March 1973. The lead concentration in soil was determined by the atomic absorption and spectrophotometric methods. The lead concentration of the upper layer ranged from 18.5 to 168.5 ppm and the lower layer from 13.0 to 205.0 ppm. The ratios of lead in upper and lower layers are given, indicating the higher concentration in the upper layer in most cases. The natural soil contains a certain amount of lead, therefore it is difficult to assess the extent of lead pollution by automobile exhaust from the result of one survey. The lead concentration in Kagoshima city is higher than that of other smaller cities, which may possibly be the indication of pollution by automobile exhaust gas.
Source: 1

#614
Matsuoka, Y. "Nosaku butsutai seibun kara mita taiki osen shitsu kaksusan ni tsuite." (Polluted air diffusion by analogy with element concentration in plants). Text in Japanese. Kogai to Taisaku (J. Pollution Control) 7(10):21-35 (1971).

Pollution conditions of the Ichihara area in the Chiba prefecture were examined, using chemical analysis of plant body elements as indices. Sulfur absorbed from the soil into the plant was carefully examined before determining damages from air pollution. Sulfur content in summer corn in polluted area showed little difference, except for one location, from that of the controlled area. But sulfur content in wheat measured during winter showed more than 50% higher figures in all locations of the polluted area compared to figures in the controlled area. Figures obtained at two locations were two and three times over that of the average of the controlled area. From an analysis of the sulfur content pattern, emission source could be determined. The relationship of winter weather and pollution was studied by a wind tunnel experiment and it was confirmed that the Ichihara area was polluted most frequently when a strong north wind was caused by a high pressure in the north. Pollution was limited to the season when the wind direction was from the sea toward the land. Areas up to four km in the lee from the emission source were heavily polluted, but up to eight or nine km, they were also polluted though less heavily. The stack heights of the main smoke sources are less than 100 m, and the highest sulfur dioxide concentration was 0.13%. Sulfur content in the leaves of pear trees in the polluted area was mostly from 0.230% to 0.40% compared to the average of 0.127% in the pear leaves of the control area.
Source: 1

#1550
Matsunaka, S. "Kokagakuteki taiki osen busshitsu no shokubutsu e no eikyo." (The effect of photchemical air pollutants on plants). Text in Japanese. Seikatsu to Kankyo (Life Environ.), 18(8):17-21 (1973).

The injuries that ozone causes on plants include the formation of white or brown spots on leaves, the bleaching or browning of leaves, necrosis, and leaf falling. The injuries caused by peroxyacetyl nitrate were the same as those caused by ozone except that the damage was greater on premature leaves. The plants that are weak in resistance to ozone are tomato, pinto bean, tobacco, spinach, potato, alfalfa, peanut, and grape; and those strong in resistance to it are gladiolus and red pepper. The plants that are weak in resistance to PAN are pinto bean, red beet, chickweed, dahlia, lettuce, and tomato, and those strong in resistance to it are begonia, chrysanthemum, corn, cotton, cucumber and balsam. The resistance depends largely on the plant and the pollutant. Therefore, the plant indicator method probably is the best way to monitor the effect of a given pollutant on certain plants. Morning glories were planted in the gardens of 200 homes in Osaka city to study the resistance to certain pollutants and similar studies were also conducted at grade and high schools in other cities.
Source: 1

#1552
Matsuoka, Y. "Taikiosen no yoru shokubutsu no higai hatsugen ni oyobosu Kakushu yoin." (Several factors on the appearance of plant damage by air pollution). Text in Japanese. Shokubutsu Boeki (Plant Prot.), 27 (6):234-240 (June 1973).

Damage to plants caused by air pollution is discussed. The phytotoxicity of pesticides, susceptibility of plants, and environmental factors such as weather and soil conditions are mentioned. Susceptibility is species specific, for instance, it is varied in different species affected by sulfur dioxide. Species specificity is related to morphological structure, function of enzymes, and physiological reaction. The susceptibility of a plant to one pollutant does not mean it is susceptible to another pollutant. The environmental factors such as light, temperature, and moisture affect the damage caused by air pollutants. Generally, as humidity increases, so does damage. Soil moisture, nutrients, texture, temperature, and oxygen partial pressure also affect the activity of plant roots and thus plant susceptibility. Generally, shortage of soil moisture decreases susceptibility and abundance of fertilizer increases susceptibility. Certain stages of growth are more susceptible to pollution than other stages. Time of day and season can also affect the amount of damage.
Source: 1

#1551
Matsuoka, Y. "Taiki osen ni yoru shokubutsu higai (7) fukka suiso ni yoru nosakumotsu no higai." (Plant damages due to air pollution, Part VII: damages of agricultural crops due to hydrogen fluoride.) Text in Japanese. Nogyo Oyobi Engei (Agr. Hort.), 49(7):1-2 (July 1974).

Hydrogen fluoride, silicon tetrafluoride, and other fluorine compounds are toxic to plants. Silicon tetrafluoride converts to HF, causing HF toxic symptoms to plants. Aluminum refineries, steel plants, superphosphate firms, and potteries emit fluorides. Hydrogen fluoride causes long-term damage at 1-5 ppb and acute damage at 10-50 ppb. Rice plants exposed to 50 ppb HF for 48 hrs were severely damaged. Rice plants near an aluminum refinery were also damaged. Welsh onions exposed to 30 ppb HF for 6 hr and photographed after 48 hr and red clover exposed to 70 ppb for 11 hr and photographed after 48 hr were also damaged.
Source: 1

#1206
Matsuoka, Y., T. Takasaki, M. Morikawa, K. Shiratori, and S. Omiehi. "Kuki joka-ho ni yoru shokubutsu no taiki osen higai no kensaku." (Investigation of photochemical air pollution damage to plants using filtered air chamber). Text in Japanese. (Presented at the Japan. Society of Air Pollution, Annual Meeting, 14th, Fukushima, Japan, Paper 265, Nov. 6-8 1973.) Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):539 (Oct. 1973).

To obtain more accurate results for the epidemiological study of air pollution damages of produce, a filtered air chamber was devised. The chamber is made of glass and translucent phylon, with a suction duct taking in the outside air through a filter of activated carbon and manganese dioxide, eliminating oxidants (ozone) up to 88% and sulfur oxides up to 90%. The light, ventilation, temperature, and humidity are controlled and plants can be grown either directly or in pots. For comparison, a similar chamber with identical structure and ventilation conditions but without the filter was constructed. Tobacco, spinach and taro potatoes grown out of doors and in the unfiltered chambers showed damages of O_3 on July 31, Aug. 4, and Aug. 9, with clear and characteristic symptoms. Those were the day, or days after a high oxidant concentration including some photochemical phenomena. The plants grown in the filtered air chamber showed no sign of damage. The external appearances and microscopic study of tissues agreed with the known damages by O_3. The taro potaotes which were introduced to special taro virus showed no special relationship with the pollution. Incidents of damages of produce which have frequently occurred in Chiba prefecture in recent years were mostly caused by O_3.
Source: 1

#613
Matsuoka Y., T. Takasaki, and O. Udagawa. "Chiba ken ni okeru hosakubotai ijo to okishidanto rui no kankei no tsuite no suisoku." (Presumption of the relationship of crop plants injury to air-borne oxidants in Chiba Prefecture). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):140 (1971).

The effects of air pollution on the plants and vegetables a Chiba Prefecture were investigated. The injuries on wheat, onion, taro, leek, and corn were remarkable. Pollution caused the falling of leaves from zelkova trees. The symptoms of all the harvests were different from those of any previous plant diseases. The symptoms were also different from those due to over-humidified, over-dried, or abnormal temperature conditions. The weather conditions one to two days before the injuries occurred were always accompanied by breeze, and the concentrations of sulfur dioxide and oxidants in air were high. The symptoms of one plant were the same as those reported in the U.S.A., believed to be due to oxidants, especially ozone, in air. The injuries were due to the oxidants which contained chiefly ozone.
Source: 1

#616

Matsuoka, Yoshihiro, Tsuyoshi Takasaki, and Osamu Udagawa. "Fussokei taiki osen ni yoru suitoyochu no fusso shuseki ni tsuite." (Fluorine accumulation in rice plant leaves with air-borne fluoride). Chiba-ken Nogyo Shikenjo Kenkyu Hokoku (Bull. Chiba-Ken Agr. Exp. Sta.), 12:57-62 (March 1972).

Injury of rice plants due to fluorine emitted by aluminum refining and phosphate fertilizer plants in the Keiyo heavy industrial district of Chiba Prefecture in July 1969 and July 1970 was studied. The fluorine determination by AOAC procedure was unsuitable for siliceous vegetation such as rice because of the large amount of silica contained. An improved procedure of fusing calcination with sodium carbonate was more accurate. The new procedure was used to determine F in this investigation. Fluorine caused leaf blade necrosis, but scarcely damaged the leaf sheath before the heading stage. Remarkable injury appeared on the tip of the leaf blade, but was slight on the lower portion of the leaf. The leaf also changed color. Irregularly shaped chlorotic spots appeared in the healthy tissues of severely injured leaves. A large amount of fluorine was contained in the rice leaf, but only a little was found in the stem, leaf sheath, and ear. Concentrations of F in the leaf differs according to the leaf position on the stem. The highest concentration of F was contained in the most severely damaged leaves. Fluorine was scarcely translocated to stem or ear from the leaf. Seven hundred ppm of F on a dry weight basis was contained in the tip of the leaf blade, and 80 ppm F in the base of the leaf. Fifty-six percent of the total F was accumulated in the tip of the leaf. Almost all of the F was accumulated in necrotic tissue of the injured leaf. The remarkable rice injury occured 1-2 km downwind from the major source of F, and slight injury occurred within 3 to 4 km. From the leaf analysis, F was confirmed to be absorbed in leaves within 4-5 km where visible injury was not recognized.
Source: 1

#617

Matsuoka, Y., T. Takasaki, and O. Udagawa. "Shokubatsu yochu ni shuseki suru io seibun to taikichu no aryusan gasu ni tsuite." [The relations between atmospheric sulfur dioxide and accumulated sulfur in foliage]. Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):538 (Oct. 1973).

The cumulative effects of low concentrations of sulfur dioxide, which are often not visible in plants, were measured by sulfur accumulation measurements in leaves. Potted pear seedlings were exposed to a low concentration (0.15-1.20 ppm) of SO2 for 8 hr a day, up to 400 hrs. The results showed that the total S amount in leaves increased by exposure, but nonsoluble to S content in leaves did not show any difference from the control group; they were within the range of 61-29 mg/100 g. Sulfur absorbed in the form of SO2 gas was deposited in leaves in soluble form. When leaves are exposed to the same concentration of gases but for different lengths of time, the absorption rate decreased for each longer exposure time. When the total exposure concentration remained the same, the higher the concentration and the shorter the exposure time, the accumulation quantity was smaller. The lower the concentration, the greater the cumulative amount of S. The absorption speed is higher when concentration is higher.
Source: 1

#615
Matsuoka, Yoshihiro, Hisami Yamada, Tsuyoshi Takasaki, Osamu Udagawa, and Toshiro Ono. "Nashi no jusei sayo ni oyobosu aryusan gasu no eikyo." (Effects of sulfur dioxide on pear pollination). Chiba-Ken Noygo Shikenjo Kenkyu Hokoku (Bull. Chiba-Ken Agr. Exp. Sta.), 11:41-46 (March 1971).

Pear trees were fumigated with 0.5 and 0.2 ppm of sulfur dioxide and mist of 1/500 sulfuric acid for 8 hr in a chamber which was modified as an artificial growth chamber with meteorological control equipment. The effect of gasses on fruiting and fertilization of pear trees were examined with artificial pollination. A plot was pollinated 1 hr before gas fumigation, B plot was pollinated 4 hr after fumigation, and C plot was pollinated immediately after fumigation. Visible abnormalities and spotted symptoms caused by fumigation were not observed on the plant. In the case of fumigation by 0.5 ppm SO2, injurious effect on fruiting was especially significant in B plot, and was found in all the plots. Fruit shedding was slightly observed with 0.2 ppm SO2 and was more significant in B plot than in A and C plots. When a number of fertilized seeds of young fruit was examined, the mean seed number per fruit was lower in the pear fruit treated by gases than in the controlled fruit B plot which was treated by a high concentration of SO2, had the lowest fertility rate; the mean number of seeds was 5.7.
Source: 1

#16
Matsushima, Jiro. "Norin sakumotsu ni oycbosu taiki osen no eikyo." (Air pollution effect to the agriculture and forestry). Ryusan (J. Sulphuric Acid Assoc., Japan), 24(6):22-36 (June 1971).

Influences of sulfur dioxide, agricultural chemicals, nitrogen oxides, and hydrogen fluoride on plants and agricultural produce are discussed. A common damage of SO_2 is chlorosis and withering of red pines. The mechanism of damage has not been explained satisfactorily, but it is clearly caused by SO_2 oxidation reduction. A plant in its budding stage has a large respiratory capacity and a small photosynthesis ability; as leaves grow, the latter increases and the former decreases, thereby increasing production and accumulation of the carbohydrate. The quantity of SO_2 absorption increases with the increase in the surface area of leaves, yet a plant's SO_2 absorption capacity has little to do with its respiratory capacity. It is more influenced by the tree's photosynthetic capacity. This is supported by the fact that an orange tree shows the same amount of resistance when exposed to 30 C and 95% humidity in middle March and forced to bud, as it does during winter. Respiration of a tree in winter will increase in high temperature and humidity, but metabolism does not increase. When metabolism is small, the influence of SO_2 is small. Spraying trees with glutathione is effective against oxidant damage but it enhances the SO_2 damage. The reason might be that glutathione increases photosynthesis or impairs SO_2s reduction of photosynthesis, thus causing the tree to absorb more gas.
Source: 1

#832
Matsushima, Jiro. "Shokubutsu ni taisuru aryusangasu to okishidanto no fukugogai ni tsuite." (On composite harm to plants by sulfurous acid gas and oxidant). Sangyo Kogai (Ind. Public Nuisance), 7(5):218-224 (May 1971).

The composite effects on plants of sulfur dioxide and ozone, SO2 and PAN (peroxyacetyl nitrate) SO2, and nitrogen dioxide, and NO2 and ozone were studied. Pinto bean plants were exposed to SO2 or 03 only, to each gas alternately, and to a mixture of the two. The degree of injury by the gas or gasses was indicated in percentage by area of the leaves damaged. In cases where no geometric effect occurred the damage to the plant by the individual gas had been great; damage from the individual gas had been slight in those case where such an effect was observed. The geometric effect is produced when the density of SO2 is rather low, generally 0.05-0.25 ppm. A mixture of SO2 and 03 was applied to a tobacco plant; it affected fully grown leaves as reported by Menser. In experiments on those composite effects of SO2 and PAN on bean, tomato, and pepper plants, PAN affected mainly young leaves while SO2 effected mature ones. These effects were arithmetic rather than geometric. The SO2 and NO2 were also studied in the same manner. When SO2 and NO2 were mixed, a geometric effect was conspicuous in damage to vegetables, the symptoms of damage by either of the two appeared about the same, younger leaves being affected less. When treated with the two gases alternately, the damage was greater if the plants were first treated with NO2; possible causes for this effect are discussed. No significant composite effect of NO2 and 03 was observed.
Source: 1

#1560
Matsushima, Jiro. "Kokagaku hanno busshitsu no shokubutsu no oyobosu eikyo." (The effects of photochemical reaction substances on plants). Japan Society of Air Pollution, Proc. Japan Soc, Air Pollut. Meet. Air Pollut. Caused Photochem. Reaction, p. 171-181 (1972).

The effects of airborne pollutants on plants are discussed. Since the photochemical substances contain mostly ozone, it is believed that plant damages are mainly due to the action of this product. Brown spots appear on all leaves of tobacco plants exposed to 0.11 ppm 03. Classes which have higher sensitivity to 03 are Avena, Lycopersicum, Nicotiana, Phaseolus, Pinus, Poa, Polygonum, Solanum and Spinach Avena, Phaseolus, Poa, Lycoperisicum, Petunia, Dahlia, Lactuca, Brassica, and Urtica, are also sensitive to peroxyactyl nitrate. At 14 ppb for 4 hours, these plants all showed injury. Nitrogen dioxide and sulfur dioxide showed significant synergistic effects on the injuries of leaves of Lycoperisicum.
Source: 1

#1553
Matsushima, J. "Nisanka io oyobi nisanka chisso ga natsudaidai jissei no aminosan, yukisan oyobi torui no doka ni oyobosu eikyo." (Influence of sulfur dioxide and nitrogen dioxide on assimilation of amino acids, organic acids, and saccharoid in Citrus natsudaidai seedlings). Text in Japanese. Mie Daigaku Hogakubu Gakujutsu Hokoku (Bull. Faculty Agric. Mie Univ.), 44: 131-139 (Nov. 1972).

The influence of sulfur dioxide and nitrogen dioxide on assimilation of amino acids and organic acids from carbon-14-labeled carbon dioxide was studied in Citrus Natsudaidai seedlings. Fumigation of 20 ppm SO_2 for 1 hr resulted in a decrease in the cationic fraction of amino acids, and the observance of a medium degree of visible injury. The effect of NO_2 was less than SO_2, and 40 ppm fumigation for 16 hr caused only slight visible injury. A remarkable difference, however, was noted between the effect of SO_2 and NO_2 on metabolism of organic consituents. Nitrogen dioxide markedly stimulated more amino acid assimilation and more decreased organic acid than SO_2. Different mechanisms appear to be associated with the effects of SO_2 and NO2 despite the similarity of visible injuries.
Source: 1

#1562
Matsushima, Jiro. "Chisso sankabutsu no shokubutsu ni oyobosu eikyo." (Effects of nitrogen oxides on plants). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):234-242 (Oct 1973).

The effects of nitrogen oxides on plants in fields and in experimental greenhouses were discussed. No damages to rice, soy beans, sweet potatoes, sesame, tomatoes, eggplants, pimentoes, cucumbers, strawberries, and grapes exposed to 20 ppm of nitric oxide for 7 hr were noted. There was, however, decreasing photosynthesis of tomatoes at 3.1 ppm, and of oats and alfalfa at 0.6 ppm. Nitrogen dioxide damage is usually interveinal chlorosis, especially on just matured leaves. The resistance of plants to NO2 differs among species, varieties, and strains,depending also on experimental conditions. The more susceptible plants are petunia, morning glory, mimosa, Phasaorus, popula, artemicia, plantage, and American bidens which show visible damage to 13-15 ppm for 1 hr. Moderately susceptible plants are ageratum, salvia, zinnia, scindapsus, tomato, taro, pear, malus, grape, peach, zelkova, nerium, chickweed, and chenopodium which show visible damage at 13-15 ppm for 2-5 hr. Resistant plants are Satsuma-orange, ginkgo, osmanthus, camelia, black pine, chaemocyparis, and amaranthus. Generally speaking, plants are relatively more resistant to NO2 than to SO2. However, before showing visible damage, NO2 gives physiological effects or inhibits growth which is recognized by the decrease of wet or dry weight and the decrease of nitrate-type nitrogen with the increase of total nitrogen. The uptake of 14CO2 by exposure to NO2 was far larger than by exposure to SO2, and the retained CO2 changed mainly to alamine and glutamic acid. Plant damage due to NO2 exposure was more severe in the dark than in the light. Synergism of NO2 and SO2 is frequently seen, and the damage of plants is larger when they are first exposed to SO2 and then to NO2 than when exposed to NO2 and then SO2.
Source: 1

#1563

Matsushima, J. "Onshu mikan no aryusan gasu shogai ni taisuru kakushu yakuzai no eikyo to sono sayo kisaku ni tsuite." (Influence of various chemicals on sulfur dioxide gas injuries and its mechanism in Satsuma orange). Text in Japanese. Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 2(2):160-167 (June 1973).

Results are presented from studies on the influence of various chemicals on sulfur dioxide gas injuries to Satsuma orange trees. Bordeaux mixture promoted sulfur dioxide injuriesin the form of fallen leaves and smoke lesion leaves, probably due to the copper sulfate component of the spray. Difolatan and Dithane were safely used in place of Bordeaux mixture. The insecticide Fussol (monofluoroacetamide) and the transpiration retardant OED Green (oxethylenedecosanol) decreased sulfur dioxide injuries. Chemicals which promoted photosynthesis such as glutahione and ascorbic acid tended to increase in injuries, while those which suppressed photosynthesis such as Fussol and Dithane decreased injuries.
Source: 1

#1547

Matsushima, J. "Shokubutsu o shihyo to shita taiki osen no kanshi." (Monitoring of air pollution using plants as monitors). Text in Japanese. Shokubutsu Boeki (Plant Prot.), 27(6):259-260 (1973).

Plants can be used to monitor air pollution by measuring the characteristic visible damage and its degree, the defoliation and discoloration, the retention of pollutants by the leaf, and the effects on reproduction. Indicator plants should be very susceptible to one specific pollutant or equally susceptible to every pollutant by showing specified symptoms. Such plants should also constantly develop new leaves and be resistant to diseases and insects. Alfalfa and buckwheat are used to monitor sulfur dioxide. Pinue densilflora is susceptible to SO_2. Gladioli and turnips are susceptible to hydrogen fluoride. Apricot, plum, and grape are weak indicators of HF. Tobacco and morning glory can be used to measure ozone. Petunia shows specific damage due to peroxyacetyl nitrate. Buckwheat and tomatoes react to ethylene and propylene as if they were exposed to growth hormones at levels of 0.05 and 0.1 ppm, respectively. Measuring pollutant concentrations in leaves is used to measure chronic effects of low concentrations of pollutants, such as HF in citrus leaves. Sulfur is naturally contained in normal plants and the content varies with the season, however, S content in citrus leaves is unusually high when the plants are grown in a SO_2 rich atmosphere.
Source: 1

#1556
Matsushima, J. "Kokagaku sumoggu no shokubutsu ni taisuru eikyo." (Effects of photochemical smog on plants). Text in Japanese. Kankyo Gijutsu (Environ. Conserv. Eng.), 3(7):513-518 (July 1974).

Photochemical smog damages plants through a synergistic relationship among ozone, peroxyacetyl nitrate, and nitrogen dioxides. Such plant damage was at first discovered in the outskirts of Los Angeles in 1944. Photochemical smog consists of ozone, the most abundant and the most phytotoxic; PAN relatively less in amount but nearly toxic as ozone; and of NO_2, the least toxic to plants. These three main components of photochemical smog cause necrosis, spot-like lesions, chlorosis by ozone, and injuries on the lower surface of leaves by PAN and NO_2. The existence of species specificity of susceptibility of plants against various component of photochemical smog was also described.
Source: 1

#1554
Matsushima, J. "Ozon ni yoru kaju no higai shojo." (Symptoms of fruit tree injuries by ozone). Text in Japanese. Nogyo oyobi Engei (Agri. Hort.) 49(6):1-2 (June 1974).

The characteristic symptom of fruit trees exposed to ozone is stippling on the upper surface of leaf blades. Freckle-like spots appeared on the upper surface of Prunus mume experimentally exposed to 0.2 ppm of atmospheric ozone 4-5 hr daily for 4 consecutive days in March. Similar freckle-like spots appeared on the upper surface of the leaf of Malus sieboldii exposed to 0.5 ppm of atmospheric ozone for 5 hr/day for 2 days. Injuries appear mainly on the completely developed newly grown leaves and on older ones. Other symptoms include chlorosis and necrosis of leaves. The species specificity of fruit trees to ozone is the same as that to sulfur dioxide, evergreens being more resistant than deciduous trees. Photographs are shown.
Source: 1

#1555
Matsushima, J. "Taiki osen ni yoru shokubutsu higai (5) nisanka io ni yoru kaju no higai." (Plant damages due to air pollution, Part V: Damage of fruit trees due to exposure to SO_2). Text in Japanese. Nogyo Oyobi Engei (Agr. Hort.), 49(5):1-2 (May 1974).

Fruit trees are generally less sensitive than other trees to sulfur dioxide; apples, grapes, and peaches are the most sensitive fruit trees and show early lesions after exposure for 1 hr to 2-3 ppm SO_2. Evergreen trees are generally less sensitive than citrus trees, showing smoky spots after exposure for 1 hr to 8 ppm SO_2. Near a refinery, pollution caused fruit to fall, but did not cause lesions on the fruit. Pear leaves developed smoky spots after exposure for 6 hr to 5 ppm of SO_2. Small pox-like spots formed on Satsuma oranges and pears after exposure to floating dust containing adsorbed SO_2.
Source: 1

#1561
Matsushima, Jiro and R.F. Brewer. "Influence of sulfur dioxide and hydrogen fluroide as a mix or reciprocal exposure on citrus growth and development." J. Air Pollution Control Assoc., 22(9):710-713 (Sept 1972).

The influence of exposure to mixtures of sulfur dioxide and hydrogen fluoride on Koethen sweet orange, and alternate exposure to these gases on Satsuma mandarin, were tested using a rotating fumigation greenhouse. The concentration of SO2 was effectively maintained at approximately 0.8 ppm or 2.3 mg/cu m during the experiment, but the HF concentration varied from approximately 2.5 ppb or 2.2 micrograms/cu m at the beginning of the experiment to approximately 13 ppb (11.6 micrograms/cu m) at the end. Effects of HF-SO2 mixtures on linear growth and leaf area of Koethan orange were additive, not synergistic. No necrosis was observed on Koethen oranges exposed to HF, SO2, or a mixture of HF and SO2. Effects of the mixture on chlorosis of Satsuma mandarin foliage was also not synergistic. No significant difference in linear growth of Satsuma mandarin was found. Alternate exposure to SO2 folowed by HF produced no synergistic injury to Satsuma mandarin. Satsuma mandarin appeared more sensitive than Koethen orange to HF, SO2, and mixtures of these two gases, using degree of chlorosis and leaf abscission as the criteria of sensitivity. If linear growth and leaf area were the principal criteria considered, Koethen orange would appear more sensitive.
Source: 1

#1558
Matsushima, Jiro and Manabu Harada. "Kaju no aryusangasu niyoru engai. Dai 1 po. Kaju no teikosei narabini kankitsurui no rakuyo oyobi seiiku nioyobosu eikyo nitsuite." (Sulfur dixoide gas injury to fruit trees. I. Comparisons of resistance of fruit trees and effects on leaf fall and growth of citrus species). Mie Daigaku hogakubu Gakujutsu Hokoku (Bull. of Faculty of Agriculture, Mie Univ.), p. 11-32 (Sept 25, 1964).

Various annual plants and two- and three-year old fruit trees were treated continuously in exposure chambers to 1 and 5 ppm sulfur dioxide. A short-term experiment was conducted in summer at high chamber temperature and relative humidity; in long-term winter experiments, chamber temperature and humidity were only slightly higher than atmospheric. The summer experiment showed that grape and peach trees were most sensitive to SO2, pear trees fairly sensitive, and citrus trees resistant with one exception. Tomato plants were very sensitive and rice plants moderately sensitive. Even with long-term fumigation extending over a three-week period, citrus species show no visible lessions, while most annual crops and weed plants were injured by 5 ppm within 1-7 days and some by 1 ppm within 10 to 13 days. Leaf fall of citrus species was less in winter than in summer. However, the growth of the trees was reduced by long-term exposure, suggesting that invisible injury caused by SO2 is not always negligible.
Source: 1

#1557

Matsushima, J., T. Odaira, and T. Sawada. "Kokagaku hanno busshitsu ni yoru yo-saibo no bisai kozo no henka ozon oyobi nisanka chisso ni yoru keyaki, popura oyobi asagao no denshi kenbikyoteki kansatsu." (Change of microstructure of leaf cells by photochemical reaction products - electron microscopic observation of zelkova, poplar,and morning glory affected by ozone and sulfur dioxide). Text in Japanese. In: Studies in Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 626-633 (March 1974).

After exposing zelkova for 5 hr and poplar for 3 hr to 1 ppm ozone, and after exposing three varieties of morning glory (heavenly blue, scarlet O'Hara and Hamano yosooi) to nitrogen dioxide at 20, 10 and 5 ppm, respectively, 30 min/hr and 4/hr day for five days continuously, the microstructure of the exposed plant cells was observed electron microscopically. On acute injuries, conspicuous plasmolysis was observed on both species. While plasmolysis was more noticeable than cytoplasmatic change in zelkova, plasmolysis had progressed so far as to make cytoplasm of poplar completely contracted and destroyed. After exposing Hamano-yosooi variety of morning glory to 20 ppm for NO_2 for 1 hr., disturbance of chloroplasts, especially their lamellar structure, was recognized without plasmolysis, but the mitchondrial change was not clear. After exposing heavenly-blue variety of morning glory to 20 ppm of NO_2 for 30 min. although no damage was found by the naked eye, several degrees of damage were observed by electron microscopy. Chloroplastic lamella were curved, disturbed, cut, and completely destroyed without plasmolysism but mitchondrial change was not clear. After exposing the same variety to 20 ppm of NO_2 for 1 hr. the degree of injury was so great that the chloroplast was completely destroyed with no trace of chloroplastic lamella. After exposing Scarlet O'Hara to 5 or 10 ppm of NO_2 4 hr/day for 5 days, no great change was observed except for some chloroplastic lamella being clearly cut.
Source: 1

#1264

Matsushita, S., K. Arashidani, and M. Koyano. "Tsuchi ni fukumareru hatsugansei tanka suiso no sokutei." [Determination of carcinogenic hydrocarbons in soil]. Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):452 (Oct. 1973).

Carcinogenic hydrocarbons in the mud and sand on the roads were analyzed. A simple method of analysis was devised and samples from various busy city streets were analyzed. The samples were sifted in a 28-mesh sift; 10-15 g of this material was taken and put in a Soxhlet extracter for 8 hrs; the benzene extract liquid was then filtered, condensed by reduced pressure, and a given amount was separated by two-layer primary thin layer chromatography, and the separated spots under the ultraviolet irradiation were scraped and DMSO (3 ml) was added. The polynuclear aromatic hydrocarbons in the extract were identified and measured by fluorescence spectrophotometry. In spite of the simple procedure, 10 kinds of PAH was identified and errors were within 5%. The dirt sample from a busy intersection of Kawasaki contained 0.94-22.1 ppm of benzo(a)pyrene. The asphalt content of BaP is 2.3 ppm; therefore, the high BaP content in the dirt may be regarded pollution from automobile exhaust and factory stack gas. Other BaP measurements were 0.15-0.22 ppm in the sample from the Kyoto Station; 1.34 ppm from the sample at the exit of the Nagoya Station; 2.33 ppm in the sample from the Osaka Station Northern exit; and 1.91 ppm from a sample from an Osaka subway entrance.
Source: 1

#1263

Matthess, G. "Bleigehalte in Gestein, Boden und Grundwasser." [Lead concentrations in rocks, soil, and groundwater]. In: Blei und Umwelt, Kommission fuer Umweltgefahren des Bundesgesundheitsamtes (West Germany), Arbeitsgrupps Blei, p. 21-27 (1972).

The lead in rocks, soil, and groundwater stems from several sources which can be combined into two groups, natural lead concentrations and anthropogenic concentrations. After listing the natural lead concentration found in various rocks and soils of West Germany, the Netherlands, France, Great Britain, Spain, and the U.S.S.R., the anthropogenic lead concentrations are discussed. Studies in Scotland revealed a generally higher lead concentration in urban areas compared to rural areas. They are the consequence of air pollution by combustion processes, automobile exhaust gases, pesticides, and fertilizers. A local increase of the lead concentration in the soil near Langesheim/Lower Saxony to more than 1000 mg/kg was caused by the smoke from a metallurgical plant. Higher than normal lead concentrations are found along busy streets and highways. Analysis of the lead concentration of the soil in various distances from the Autobahn Giessen/Frankfurt revealed a rapid decrease with increasing distance. This section of the Autobahn had been used by about 40 million automobiles. It is estimated that 1.2 kg lead have been emitted/m of the Autobahn. In the separating strip between the two directions, 147 mg extractable lead/kg soil was measured; at a depth of 20 to 40 cm 25 mg/kg; on the side 130 mg/kg; at 20 m distance, 26 mg/kg; at 50 m distance, 23 mg/kg; and at 100 m distance 19 mg/kg.
Source: 1

#1262

McConnell, J. C. "Atmospheric ammonia." J. Geophys. Res., 78(33):7812-7821 (November 20, 1973).

The photochemistry of atmospheric ammonia is examined. Reaction with hydroxy radicals and heterogeneous loss are the dominant removal mechanisms in the troposphere with photolysis being the most important mechanism in the stratosphere. Oxidation of NH_3 to nitric oxide in the troposphere means a source magnitude of 10 to the 14 g/yr, with such a production rate appearing adequate to balance the loss of nitrogen oxides from the atmosphere. The presence of a comparable source of NO from the soil is not required under these conditions but cannot be ruled out either. Alternatively, if destruction of NH_3 leads to loss of NO, the removal rate of NO_x in the atmosphere must be balanced by a source of magnitude of 10 to the 14 g/yr which probably results from biological soil reactions. The natural NO sources are in either case four times greater than anthropogenic sources. The potential stratospheric NO source from NH_3 is of the same magnitude as that from nitrous oxide and that from a fleet of 500 supersonic aircraft; thus, the NH_3-NO source should be included when the potential environmental effects of a fleet of SST are considered. If NH_3 loss should result in a sink for stratosphere NO, there must be an as yet unidentified NO source of comparable magnitude in the stratosphere.
Source: 1

#1261
McConnell, J. C., M. B. McElroy, and S.C. Wofsy. "Natural sources of atmospheric CO." Nature (London), 233(5316):187-188 (Sept 17, 1971).

The results of calculations to determine the natural sources of carbon monoxide are examined. Reaction rates and mechanisms were determined for the natural formation of methane and subsequently for the formation of CO. Based on the calculations, the source of CO due to CH4 was comparable to, or even larger than, that associated with the internal combustion engine.
Source: 1

#834
McCornack, A.A.,L.C. Cochran, H. English, and C.L. Hemstree. "A black tip condition on peach fruits in California." Plant Disease Reptr., 36(3):99-100 (March 15, 1952).

An unusual dead tip condition was observed in peach fruits in the Cucamonga area of California in 1950 and 1951. The symptoms on affected fruit consisted of black, generally circular, sunken areas at the blossom ends. The summation of available evidence indicates that the black tip is caused not by an infectious agent, but by some physical or chemical injury. The affected area lies within 4 to 12 miles of the Fontana steel plant, which has grown steadily in size and operation since its construction in World War II.
Source: 1

#274
McCown, B., P. Coyne, J. Brown, and R.P. Murrmann. "Chemical indicators of Arctic biological and environmental activities." Army Cold Regions Research and Engineering Lab., Hanover, N. H., DA Task 4A061101A91D03, RR-301, 30 p. (April 1972).

Two approaches were used to study the carbon cycling in a cold-dominated ecosystem at Barrow, Alaska. One involved a detailed analysis of the flow of carbon dioxide between the atmosphere, soil and biota, and the other concentrated on the internal carbon cycling in plants. A pilot study was also conducted which investigated the possibility of estimating underground plant biomass by biochemical means. Both laboratory and field studies were conducted to analyze the input of CO_2 to the Arctic atmosphere by frozen tundra soils. Data are presented which indicate that frozen soil is a major source of CO_2. It is hypothesized that CO2 trapped in soils during bi-directional freezing in the fall and winter is released during the spring thaw, thus producing a spring rise in the CO_2 content of the atmosphere. A procedure for the extraction and estimation of organic nutrients (lipids and carbohydrates) was developed and used to follow the seasonal cycle of these nutrients of plants obtained at Barrow, Alaska. No cycling in levels of carbohydrates (alcohol-soluble) was observed in the foliage during the season, however a definite cycling in lipid levels was seen for all the species studied. The species were synchronous. Plant survival and organic nutrient levels were followed during the winter over a heated-soil experiment at Barrow, Alaska. During

the winter, the heating of the soil caused ponding which resulted in the elimination of Dupontia fischeri by mid-winter and the eventual death of all plants by spring. The carbohydrate levels indicated a starvation condition was created where a marked decrease in storage polymers (starch and fructans) occurred without a concurrent large increase in the alcohol-soluble carbohydrate levels. An increase in the fresh/dry weight ratios was also observed indicating etiolated, succulent growth in early winter. Four techniques were tried for estimating the below-ground biomass of plants. Two of these were eliminated as unsuitable, however, two other methods (ATP and phospholipid levels) remain to be fully evaluated.
Source: 1

#17
McCune, D. C., and A. E. Hitchcock. "Flouride in forage; factors determining its accumulation from the atmosphere and concentration in the plant." Second International Clean Air Congress Proceedings. 4 pp. (No date).

Review of literature shows that concentration of fluoride in forage is directly proportional to the mean concentration of HF and to the length of exposure period. Factors or conditions affecting fluoride concentration were reviewed. Light and temperature are known to be factors. Experiments conducted to determine role of those two factors. Regression models generated to establish quantitative relation between flouride concentration in forage and atmospheric concentration of HF and length of exposure period.
Source: 8

#1147
McCune, D. C., A. E. Hitchcock, J. S. Jacobson, and L. H. Weinstein. "Fluoride accumulation and growth of plants exposed to particulate cryolite in the atmosphere." Contrib. Boyce Thompson Inst., 23:1-11 (1965).

Air-borne fluoride may comprise both gaseous and particulate forms and, therefore, an understanding of its consequence to agriculture must be based on air sampling data that distinguish between the two forms (9) and on a knowledge of the effects of each type of fluoride on plants. Since most of the present knowledge of the effects of atmospheric fluorides on plants is based upon the results of investigations in which HF or other volatile fluorides were used, the following studies were carried out to provide more information on the effects of particulate fluorides.
Source: 5

#1565
McCune, D. C., D. H. Silberman, R. H. Mandl, L. H. Weinstein, P. C. Freudenthal, and P. A. Giardina. "Studies on the effects of saline aerosols of cooling tower origin on plants." (Presented at the Air Pollution Control Association Annual Meeting, 67th, Denver, Colo., June 9-13, 1974, Paper 74-251.) Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 20 p. (1974).

A research program was initiated to determine the relationship between concentrations of saline aerosol of cooling tower origin and the risk of injury to indigenous and cultivated plants of the Indian Point, New York area. Chambers and aerosol generating and monitoring apparatus were constructed to allow the exposure of plants to saline particles of expected composition, characteristics, and concentration under controlled environmental conditions. Experiments with 1 micron particles and nine species of deciduous, woody plants indicate that: flowering dogwood and white ash are more susceptible than red maple; witch hazel, white oak, forsythia, black locust, mimosa, or golden rain tree; an increase in relative humidity (RH) from 70% to 85% increases the toxicity of the aerosol to ash and dogwood, and, at a nominal concentration of 2000 micrograms chloride/cu m and at 85% RH, the threshold exposure for injury is about 14 hours for dogwood and ash but above 25 hours for the other species. Results of exposures of pinto beans to saline aerosol greater than 100 micron at 85% RH show that the median effective exposure for producing observable follar lesions is about 1 hour at an apparent concentration of 700-900 micrograms chloride/cu m or deposition rate of 0.35 micrograms chloride/sq cm/ min. An increase in the relative humidity from 50% to 85%, either during the exposure period or after it, increases the susceptibility of pinto beans or the toxicity of the saline aerosol.
Source: 1

#1564
McCune, D.C., P.J. Temple, and A.M. Witherspoon. "Acceptable limits for air pollution dosages and vegetation effects: Fluoride." Presented at the Air Pollution Control Association Annual Meeting, 67th, Denver, Color., Paper 74-226, 12 p. (June 9-13, 1974).

The relationship between the occurence of atmospheric fluoride and its effect on vegetation is studied to formulate acceptable limits for air pollution and suggest changes in the design and operation of an emission source. Limiting values for the concentration of hydrogen fluoride range form 10 to 5 ppb for 2- to 4-hour peak concentrations, from 0.6 to 0.3 ppb for mean concentrations of periods of 30 to 60 days, and 4 to 1 ppb for daily mean concentration depending upon the magnitude of diurmal fluctuations and the degree to which days of greater concentration tend to cluster together. These values are derived from experimental fumigations of plants with HF and there are several criteria for their selection. The risk of an unacceptable effect should be low where this risk depends in part upon the susceptibility, size, and function of the plant populations to be protected. Periods for which the limiting concentrations are selected should consider the effects of both short and long term exposures, temporal variability in atmospheric concentrations, and time-dependent changes in the susceptibility of plants to HF.
Source: 1

#833
McCune, Delbert C. and Leonard H. Weinstein. "Metabolic effects of atmospheric fluorides on plants." Environ. Pollut., 1:169-174 (1971).

The metabolic effects of atmospheric fluorides on plants are reviewed. Results of studies on the effect of the pollutant on individual enzymes in vitro, isolated plants or plant parts, enzyme activites, pool sizes of various metabolic intermediates in fumigated plants, or physiological processes such as photosynthesis or respiration in plants exposed to atmospheric fluorides are discussed. Each approach yields important information, but the results must be interpreted in the light of the characteristics and limitations of the systems employed. Fluorides may act as metabolic inhibitors in a process in which the pollutant reacts with metabolically active site to render it inactive. Presumably this site is in enzyme, although coenzymes or activators may be targets of the pollution. The inhibition of the enzyme results in an inhibition of the reaction mediated by that enzyme. The degree of inhibition depends on the concentration of the inhibitor at the active site, and this in turn depends on the amount and distribution of the inhibitor within the cell.
Source: 1

#970
McElroy, M. B., and J. C. McConnell. "Nitrous oxide: a natural source of stratospheric NO." J. Atmos. Sci., 28(6):1095-1098 (1971).

Supersonic transport planes currently under development will cruise in the stratosphere and there is concern about possible environmental effects. In particular, NO emitted by these aircraft may catalytically affect atmospheric ozone. Here we investigate an important natural source of NO, the reaction $O(^1D) + N_2) \rightarrow 2NO$, and compare the natural source with estimates for the source due to a fleet of 500 planes cruising for an average of 7 hr. a day. The natural and artificial inputs above 15 km are of comparable magnitude. The natural source corresponds to a net production of NO, averaged over the globe, of about $2X10^7$ molecules cm^{-2} sec^{-1}, and offers a yardstick for judging the possible significance of any artificial input. Additional sources of stratospheric NO, due to downward diffusion from the ionosphere and upward transport from the earth's surface, are discussed but have not been quantitatively estimated at this time.
Source: 5

#1566
McGovern, P.C. and D. Balsillie."How sulphur dioxide affects vegetation in the Sudbury area." Water Pollution Control (Toronto), 111(3):70, 73-74, 76-79 (April 1973).

The incidence and degree of vegetation damage caused by sulfur dioxide in the Sudbury industrial area were investigated. Sulfur dioxide concentrations were measured on a daily, monthly, and yearly basis, and data were correlated with wind speed and direction, distance from smelters and vegetation injury. The daily SO_2 values ranged within 0.01-1.97 ppm, with 11.2% of the readings above 0.25 ppm. To correlate the effects of various SO_2 concentrations with duration of fumigation, intensity factors were computed. Most vegetation injury occurred at 0.95 ppm for SO_2 for a 1-hr. duration, 0.55 ppm for 2-hr., 0.35 ppm for 4-hr., and 0.25 ppm for 8 hr.
Source: 1

#835
McKee, Herbert C. "Use of vegetation to measure air pollution." Presented at the Instituto Mexicano de Ingenieros Quimicos, Annual Technical Meeting, Mexico City, Mexico, 10 p. (Oct 19-21, 1961).

The sequence of procedure in the conduct of an air pollution survey based on plant damage is delineated. The first step is a field inspection of all vegetation in the area by a trained plant scientist to determine damage caused by pollution vs damage from other factors, and possibly to locate sources of local pollution. Samples are then collected and analyzed, by prescribed methods to identify the atmospheric pollutants that have caused the damage. The importance of having control samples is stressed. An example of the use of vegetation techniques in an air pollution survey is given for Houston, Tex. The area was divided into sectors and samples obtained for analyses from each section throughout the year; these values were then used in computing a pollution index based on vegetation damage. Native elm and the Arizona ash were studied as indicators of sulfur dioxide pollution. Vegetation symptoms could be used readily to obtain information on general pollution conditons in the Houston area, and that despite the limitations of the method, the pollution indexes thus derived provided data which could only be obtained at great expense using atmosphere analyses techniques. A table is included on the use of plants in determining pollution via visible damage and chemical analysis, for 10 general types of phytotoxic air pollutants.
Source: 1

#600
McLay, C.L. Wind-blown dust as a source of nutrients for aquatic plants." Environ. Pollut., 5(3):173-180 (1973).

The response of Lemna perpusilla to dust washed from the stems of Scirpus californicus which grows with the duckweed was investigated. Duckweed growth was stimulated by the washings and dust that had accumulated on a concrete wall near the lake. Since dust from both sources produces an immediate growth response by duckweed, the dust must contain soluble nutrients. There is some evidence that salts leached from the Scirpus stems may have been partially responsible for the increase in growth. The utilization of nutrients from this source by aquatic plants represents a previously unsuspected pathway in the nutrient cycle of a lake.
Source: 1

#1567
McMurchie, E.J., W.B. McGlasson, and I.L. Eaks. "Treatment of fruit with propylene gives information about the biogenesis of ethylene." Nature (London), 237(53,52):235-236 (May 1972).

The influence of exogenous ethylene on the concomitant endogenous production of the gas in climacteric (e.g., bananas, which undergo a large increase in respiration accompanied by marked changes in composition and texture) and nonclimacteric (e.g., citrus fruits, which show no changes in respiration associated with changes in the composition of the fruit) fruits were studied. Green bananas, light green lemons, and mature oranges were ventilated with streams of ethylene free humidified air to which proplene was added at 500 ppm. In the bananas, this treatment resulted in a typical climacteric pattern of respiration, with a rise in respiatory rate and production and a decrease in respiatory quotient (RQ). An increase in endogenous ethylene production was detected more than 3-hr after the beginning of the rise in respiatory rate; in untreated bananas, the increase in endogenous ethylene production preceded the rise in respiration by about 18 hr. The effects of propylene treatment were not seen in the lemons and oranges. Two systems regulating ethylene biogenesis in the banana are proposed: a system characterized by the initiation of ethylene biogensis; and a second system in which ethylene triggers the respiatory climacteric. When propylene or ethylene is added to bananas, ethylene production by the first system is circumvented and production by the second system is initiated producing the delay in the rise and peak of endogenous ethylene production relative to respiration. Lemons and oranges apparently lack system 2. These results support the hypothesis is that the critical difference between climacteric and nonclimacteric fruits rests in their relative abilities to produce ethylene in response to low concentrations of this gas.
Source: 1

#892
Meetham, A.R. "Natural removal of pollution from the atmosphere." Quart. J. Roy. Meteorol. Soc., 76:359-371 (1950).

Observations of atmospheric pollution throughout Britain are considered in relation to the amounts of pollution emitted through the combustion of coal. The estimated weight of ash emitted into the air and the estimate, from deposit gauges, of the ash deposited, are considered likely to agree fairly well at a figure of rather over one million tons per annum (one million tons/yr). On the assumption that about 1.5 million tons of smoke are blown to sea each year, it is shown that about 1.1 million tons of sulphur dixoide are blown to sea each year; the remaining 0.8 million tons of smoke and 3.9 million tons of sulphur dioxide must be deposited in Britain, irrespective of the quantities measured in deposit gauges. The average life of a smoke particle before deposition on land is probably of the order of 1.2 days; that of a molecule of sulphur dioxide is estimated with rather more certainty to be less than 12 hours. Of the chlorides collected in deposit gauges more than half, as a rule, come from the sea, and less than half from the utilization of coal; but the ratio must vary with the position of the deposit gauge relative to the sea and to industries.
Source: 5,6

#891
Meetham, A. R. "Natural removal of atmospheric pollution during fog." Quart. J. Roy. Meteorol. Soc., 80:96-99 (1954)

Observations of atmospheric pollution throughout Britain are considered in relation to the amounts of pollution emitted through the combustion of coal. The estimated weight of ash emitted into the air and the estimate, from deposit gauges, of the ash deposited, are considered likely to agree fairly well at a figure of over one million tons/year. On the assumption that about 1.5 million tons of smoke are blown to sea each year, about 1.1 million tons of sulfur dioxide are blown to sea each year; the remaining 0.8 million tons of smoke and 3.9 million tons of sulfur dioxide must be deposited in Britain, irrespective of the quantities measure in deposit gauges. The average life of a smoke particle before deposition on land is probably of the order of 1-2 days; that of a molecule of sulfur dioxide is estimated with rather more certainty to be less than 12 hours. Of the chlorides collected in deposit gauges more than half, as a rule, come from the sea, and less than half from the utilization of coal; but the ratio must vary with the position of the deposit gauge relative to the sea and to industries.
Source: 1, 5

#1568
Menlove, H. O. "Determination of NACL contamination in pine trees by neutron activation techniques." Los Alamos Scientific Lab., N. Mex. In: Environmental Monitoring in the Vicinity of the Los Alamos Scientific Laboratory. Calendar Year 1972, p. 52-53, (March 1973). NTIS:LA-5184

Sodium chloride content in samples of ponderosa pine needles obtained from trees in the Los Alamos, New Mexico area was measured using neutron activation techniques in which the neutron radiations were obtained with a portable 252 cf (Californium) neutron source to determine if salt was responsible for the large number of brown and dead pine trees in the vicinity of roadways and drainage ditches in the area. All of samples from the diseased trees contained at least 10 times as much sodium chloride as the control samples, and the average affected sample had 9120 ppm NaCl which was 50 times greater than the average concentration in controls. Additionally, two samples were taken from opposite sides of the same large tree located near a road to establish further that the NaCl contamination originated with road salt. The sample from branches on the road side of the tree showed 11,000 ppm NaCl, whereas the sample from the opposite side of the tree had only 2500 ppm salt.
Source: 1

#1569
Menser, Harry A., Jr. "The effects of ozone and controlled-environment factors on four varieties of tobacco, Nicotiana tabacum L." Maryland Univ., College Park Dept. of Agronomy, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 145 p. (1962).

Effects of ozone and controlled-environment factors such as light, temperature, and relative humidity on greenhouse-grown tobacco plants were studied. The threshold ozone injury for 2 hour fumigations was between 0.10 and 0.22 ppm. Injury thresholds for the cigar wrapper varieties Bel-W3, AST-C, and 56-92B were respectively 0.10, 0.16, and 0.22 ppm. Catterton variety and showed equal resistance to ozone. Correlation was found between ozone sensitivity and physiological maturity of leaves. Young, rapidly expanding leaves were damaged only at the tips, while on recently-matured leaves entire laminar surfaces were highly ozone-sensitive. Three, four, and five-hour exposures to ozone at 0.08 ppm caused light to moderate injury to Bel-W3 and AST-C but caused no suppression of growth. Growth was significantly less following repeated fumigations at ozone levels of 0.15 to 0.20 ppm. The route of ozone entry was through stomata of the lower surface. Preconditioning plants to a 22-hour light photoperiod resulted in nearly complete ozone protection of all varieties except Bel-W3. All varieties were severely damaged when preconditioned in the dark for 12 to 70 hours periods. Tobacco plants were also damaged when fumigated in the dark, but the amount of damage was less than what was produced during control fumigation under lights. Ozone damage to plants grown for 2 weeks at a 10 F average temperature differential was significantly less with the cooler temperatures. The combined effects of temperature and relative humidity during fumigation showed severe damage at 60 F and 95% relative humidity and little damage at 90 F and 50% relative humidity. Significant increase in ozone above 70% relative humidity and maximum sensitivity at 80% relative humidity were observed. Weather fleck damage to the four test varieties was of the same differential relation as damage caused by ozone.
Source: 1

#1570
Menser, H.A., H.E. Heggestad, O.E. Street, and R.N. Jeffrey. "Response of plants to air pollutants. I. Effects of ozone on tobacco plants preconditioned by light and temperature." Plant Physiol., 38:605-609 (1963).

An investigation was conducted to study the interrelation of environmental preconditioning and the response of four tobacco (Nicotiana tabacum L.) varieties to ozone. Light and temperature caused significant effects on the response of 8-week old tobacco plants exposed to ozone in a filtered air fumigation chamber. Two-hour fumigations at 0.20 to 0.25 ppm showed: a 22-hour extended photoperiod caused nearly complete ozone protection; and severe injury occurred when plants were kept in the dark for 42 or 66 hours before exposure to ozone. Observations of stomatal activity indicated that light and dark preconditioning caused no injury-correlated patterns of stomatal behavior. Other 2-hour fumigations revealed a 5 deg difference during the 2-week cultural period before fumigation resulted in significantly less injury to plants grown at the lower temperatures; and an overnight temperature of 5 deg resulted in less damage than when plants were kept at 25 deg during the same period.
Source: 1

#1870
Menser, H.A. and G.H. Hodges. "Oxidant injury to shade tobacco cultivars developed in Connecticut for weather fleck resistance." Agron. J., 64(2):189-192 (March-April, 1972).

Thirteen tabacco cultivars developed by the cigar industry for resistance to weather fleck in Connecticut were tested in Beltsville, Md. for their responses to air pollutants. Most of the unproved cultivars showed significantly more resistance to ozone than AST-C (Bel-C), a cultivar no longer grown because of its susceptibility to weather fleck. Two-hour fumigations at 10 pphm 03 inflicted less than 10% injury on commercial cultivars. The same dosage injured about 20% of the leaf surfaces of Bel-C. Ozone used at 20 and 25 pphm produced about 25% injury on the two most resistant selection, GC 18 and CCC-L. The same rates destroyed 60-70% of the leaves of Bel-C. Weather fleck evaluations in the field disclosed that photochemical oxidants injured less than 3% of the leaf area of three commercial cultivars, but damaged 55% of the leaf surfaces of Bel-C. The most leaf injury to an improved cultivar was 25%. Improved cultivars displayed less than 20% fleck damage in the first and second harvest primings, compared to 75% damage in the same two primings of Bel-C.
Source: 1

#112
Menzel, R.G. "Airborne radionuclides and plants." In: Agriculture and the Quality of Our Environment, N.C. Brady (ed.), AAAS Publication #85, Washington, D.C., p. 57-75 (1967).

Airborne radionuclides readily contaminate plant surfaces. In the presence of airborne fission products at a relatively low level, for example, the amount of radioactivity deposited on plant surfaces may exceed the radioactivity of elements normally present in the plants.

Most of the fission products and naturally radioactive elements in the air are carried on solid particles. In highly contaminated zones close to a nuclear explosion, the particles might be relatively large, from 1 micron to several hundred microns in diameter. Worldwide fallout and natural radioactivity are associated with smaller particles, from a 0.1 to 1 micron in diameter. Important gaseous radionuclides include naturally occuring carbon 14 as carbon dioxide, hydrogen 3 as water vapor, and fission-product iodine 131.

Rainfall is very important in the deposition and removal of radioactive particles from plants. The dominating mechanisms for dry deposition are gravitional settling for large particles and eddy turbulence and diffusion for gases. Mechanisms for deposition of the important submicron particles are not well understood. Further study of the deposition and removal of submicron particles from plants might be very helpful in suggesting ways to minimize levels of contamination in plants.

Radiation damage in plants is exceedingly difficult to detect except at levels of contamination thousands of times higher than those attained with worldwide fallout. The avoidance of unnecessary radiation exposure through transfer of radionuclides to human diets is, however, of direct interest to everyone.
Source: 7

#225

Meyer, M.W. "Absorption and release of ammonia from and to the atmosphere by plants." Maryland Univ., College Park, Dept. of Agriculture, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., order no. 73-28, 881 60 pp. (1973).

Since the average ammonia concentration in the U. S. is 20 micrograms/cu m, and the industrial area of New Jersey averages 57 micrograms/cu m,foliar absorption of atmospheric NH3 was studied. Plants were grown in air containing 22, 110, and 320 micrograms of nitrogen(15) NH3/cu m. The aerial portions of corn, pigweeds, pind seedlings, and soybeans absorbed NH3 at a concentration of 22 micrograms/cum. The absorption of NH3 was linear when the concentrations were 22, 110, and 320 microgram/cu m. Only 30% of the 15N-NH3 was retained by the plants, 10% was found in the exiting air, and 60% was unaccounted for. This suggests the possibility that the plant or the organisms associated with the aerial portions of the plant may have been instrumental in the loss. The plants were definitely an atmospheric sink for NH3 in normal air. It was possible, because of the design of the equipment, to fertilize the soil with 15N and to study the evolution of 15N-NH3 from the aerial portions of the pigweed and soybean plants contained in the plexiglas chamber. Ammonia was released from both plant species; however, only the pigweed released any appreciable quantities of 15N-NH3.
Source: 1

#1571

Michels. S., G. Croessmann, and Gerhard Scholl. "Ueber die Kontamination von Nahrungsmitteln mit Schwermettallen." (The contamination of food with heavy metals). Staub, Reinhaltung Luft, 34(1):23-26 (Jan 1974).

In the years 1970 and 1971 vegetables grown in vegetable gardens in the vicinity of a heavy metal plant were analyzed with regard to the concentrations of zinc, lead and cadmium. The vegetable samples were washed, shredded and dried at 65C. After dry ashing zinc was determined in a hydrochloric acid extract by atomic absorption spectrophotometry and lead and cadmium by stripping voltametry. It was found that the zinc quantity ingested with one single meal was higher than the daily requirement of 6 mg. For example with 250 g head salad more than 20 mg zinc could be ingested. The vegetables also contained a lead concentration which was far in excess of normal quantities. With one meal the toxic threshold limit value of 2 mg/day could be exceeded. Underground parts of plants and vegetables contained less lead than above ground parts. In 66% of the vegetables examined in 1970 determinable quantities of cadmium were found; 61% of the measure concentrations were above 0.3 ppm; 5% below this value. The average concentration was 0.98 ppm Cd. Head salad contained the highest Cd concentrations with up to 5.5 ppm. Of the vegetables examined in 1971, 15.5% contained measurable Cd quantities, the lowest concentration measured was 0.5 ppm. The average concentration measured in 1971 was 2.34 ppm.
Source: 1

#1572

Michler, R. "Pflanzliche Indikatoren der Umweltverschmutzung." (Plants as indicators of the environmental pollution). Text in German. (Presented at the Hohenheim University Umweltforschung Seminar, 1971.) Umweltforschung, 58:19-22 (1971).

Possibilities of surveying air pollution by means of indicator plants are reviewed. Though the effects of air pollutants such as sulfur dioxide and nitrogen oxides on plants are dependent on several factors such as plant species, stage of development, weather, pollutant concentration, and part of the day, it is possible to use certain plants, especially lichens, as indicators of the degree of air pollution. Comparative observations of vegetation over a period of years, and the exposure of transplated plants in selected sites represent two different, though complementary, methods for the use of indicator plants.
Source: 1

#836

Middleton, John T. "Biological systems for the identification and distribution of air pollutants." In: Problems and Control of Air Pollution, F.S. Mallette (ed.), Reinhold, New York, Chapt. 7, p. 64-68 (1955).

The response of plants as a biological system to air pollution is a convenient method for (1) recognizing the presence of contaminants, (2) determing distribution of pollutants, (3) providing a passive collection system for subsequent chemical analysis, and (4) assisting in an estimate of the level of pollution. Among the more important limitations of the method are the nonspecific response of some plants to certain chemically different airborne constituents, and the effect on plant response of environment prior to and during plant exposure. Several examples are given of plant observations substituting for or supplementing instrumental monitoring and recording methods. A study of the relation between plant damage and oxidant level was aided by knowledge of plant response to ozone and oxidized hydrocarbons; evaluation could not have been made with instrumentation alone since the machine (an oxidant analyzer) apparently cannot distinguish between the two oxidants. A summary of data is given on the geographic distribution of phytotoxic oxidants for the southern California coastal basin, and the question of the growth suppressant effect of atmospheric oxidants on plants is briefly noted.
Source: 1

#115

Middleton, J.T. "Air - An essential resource for agriculture." In: Agriculture and the Quality of Our Environment, N.C. Brady (ed.), AAAS Publication #85, Washington, D.C., p. 3-9 (1967).

Discusses air pollution and effect on agriculture. Most damaging air pollutants on basis of measurable economic effects (in order of importance): sulfur oxide, ozone, fluorides, peroxyacetal nitrates, ethylene, chlorine, and nitrogen dioxide. Organic vapors from vegetation may also contribute to the formation of air pollutants by photo-oxidation with nitrogen oxides - notably coniferous forest.
Source: 7

#1974
Middleton, J. T. "Planning against air pollution." American Scientist, 59:188-194 (1971).

Symptoms in humans due to exposure to various air pollutants are discussed. Two contributions to air pollution, motor vehicles and industries, are also discussed and certain controls are outlined. The author states that air pollution control hinges on the development of a wise national energy policy which reflects our concern for social and environmental objectives as well as promote economic progress. Weather is a vital factor in the air pollution problem. Simulation models are used to demonstrate alternatives in air pollution management.
Source: 8

#1573
Mihailovic, L. "Dejstvo sumpordioksida na vegetaciju." (Effect of sulphur dioxide on vegetation). Text in Serbo-Croatian. Hemijska Ind., 7:1381-1386 (1972).

The effect of sulfur dioxide on vegetation and the protective role of vegetation in terms of mechanical purification of the atmosphere are considered. Topics covered include: acute and chronic plant damage caused SO_2, concentration of the gas necessary for inducing plant damage, the mechanism of such plant damage, the utilization of vegetation as a pollution indicator, biological methods for investigating air pollution, and the hygienic role of vegetation in the environment. The protective role of vegetation in relation to SO_2 is cited as consisting more in changing the direction of SO_2 spreading than in the ability of plants to bind harmful elements in their organism. Recultivation experiments with a series of herbs and leguminosae resistant to SO_2-damage are also described.
Source: 1

#1574
Miles, C.D., J.R. Brandle, D.J. Daniel, O. Chu-Der, P.D. Schnare, and D.J. Uhlik. "Inhibition of photosystem II in isolated chloroplasts by lead." Plant Physiol., 49(5):820-825 (1972).

The inhibition of photosynthetic electron transport in isolated chloroplasts by lead salts was demonstrated in chloroplasts from spinach leaves. Photosystem I activity, as measured by electron transfer from dichlorophenol indophenol to methylviologen, was not reduced by the treatment of lead salts. However, photosystem II was inhibited by lead salts when electron flow was measured from water to methylviologen and Hill reaction or by chlorophyll fluorescence. Fluorescence induction curves indicated the primary site of inhibition was on the oxidizing side of photosystem II. This site was between the primary electron donor of photosystem II and the site of water oxidation which could be demonstrated by hydroxylamine restoration of normal fluorescence following lead inhibition.
Source: 1

#300
Miller, C. F. "Operation ceniza: the retention of fallout particles from volcan Irazu (Costa Rica) by plants and people. Part two." Stanford Research Inst.., Menlo Park, California, Contract OCD-PS-64-127, Proj. MU-4890, (283) (December 1966). CFSTI,DDC: AD 659385.

The foliar contamination data obtained in the second phase of Operation Ceniza-Arena in Costa Rica. Central America. are summarized. Measurements were made of the retention of airborne particles (ejected by Volcan Irazu) by the foliage of thirteen different vegetable plants (including corn), four different cereal grains, and six different kinds of trees. Data were obtained on both the initial contamination of the foliage and the reduction and contamination levels by wind and rain. The crops were grown at two land plots. Additional measurements included surface air temperatures, humidity, wind speed, particle size distributions, projected areas of leaves and other plant parts, planting density,composition and density of the particles, soluble salt content of the particles, contamination of persons, and particle fall trajectories. Depending on meteorological conditions and planting density, the fraction of the particles initially retained by the foliage was found to vary from almost nil to 100 percent. All plants retained at least some of all the airborne particles that arrived at the land plots, including the largest.
Source: 1

#297
Miller, C.F. "The contamination behavior of fallout-like particles ejected by volcano Irazu." Stanford Research Inst., Menlo Park, Calif., 66 p. (April, 1966).

The contamination of vegetation from volcano Irazu in Costa Rica was studied with the idea of applying the results to similar situations for radioactive fallout particles from nuclear explosions. The volcanic particles simulated nuclear weapon fallout particles containing radioactive elements. Because of the similarity in the physical properties of the volcanic fallout particles to those of the nuclear weapon fallout particles, it was concluded that the deposition and contamination behavior of the volcanic particles should be indicative of the behavior expected of nuclear weapon fallout particles. Many photographs were taken of the behavior of the airborne particles after their deposit on exposed surfaces and objects. Several of these photographs have been selected for presentation in this report. No technical data are presented; these are presented in separate technical reports. The general subjects covered by the photographic material are (1) contamination of structures, (2) contamination of streets, sidewalks, and roads, (3) contamination of automobiles, (4) contamination of people, (5)contamination of vegetation, and (6) Costa Rican decontamination methods.
Source: 1

#298

Miller, C. F. "Operation Ceniza-Arena: The retention of fallout particles from volcan Irazu (Costa Rica) by plants and people." (Part III.) Stanford Research Inst., Menlo Park, Calif., Contract OCD-PS-64-127, Proj., MU-4890, TRC-68-17, 255 p. (December 1967).

The derivation and evaluation of parametric scaling functions representing the retention of airborne particles by the foliage of various types of plants is presented in this part (Part Three) of the report on Operation Coniza-Arena. The scaling functions include, as independent variables, wind speed, particle fall angle, planting density, plant weight, time after contamination, rainfall, and plant shape factors. The output parameters include the fraction of the horizontal component of the particle flux initially retained by the foliage, the relative amount of the retained particles removed by wind-weathering, the relative amount of the retained particles removed by rain, and the rate of growth of plants (i. e., rate of accumulation of dry matter) with time after planting. Some data on the frequency distributions of plant weights and leaf areas and on the correlation between leaf area (or area of other plant parts) and the dry weight are presented. In addition, approximating functions are presented for estimating the degree of particle retention by single trees and humans. The numerical evaluation of all the scaling functions was carried out using only the data obtained from the measurements made in Operation Ceniza-Arena during the period from March 1964 through February 1965.
Source: 1

#296

Miller, C. F. "The impaction of airborne particles on plate collectors." Stanford Research Inst., Menlo Park, Calif., Contract NOO22867-C1143, Proj. SRI-MU-6358, 56 p.(April 1967).

Impaction data for a plate collector exposed to falling particles that were produced by explosive eruptions of volcano Irazu were correlated, and approximating functions for representing the impaction coefficients of the plates were derived from the data. The arrangement of the plates at 0 (180), 30, 60, 90, 120 and 150 degrees from the horizontal provided four classes of impaction geometries. An approximate relationship between the impaction or collecting efficiency of the plates and the tray collector (or the ground surface) was also derived. The plate collector data were used to estimate the effective average diameter of the falling particles, and, with a few exceptions, this diameter was always greater than the mass median diameter determined from sieve analysis of the particles. Thus it was concluded that, in the majority of the particle showers, the particles fell and impacted as agglomerates of many smaller particles.
Source: 1

#299
Miller, C. F., and H. Lee. "Operation ceniza-arena: the retention of fallout particles from volcan Irazu (Costa Rica) by plant and people (part 1)." Stanford Research Inst., Menlo Park, California, 372 pp. (January 1966).

The objectives of this research were the following: 1. Obtain exerimental data on the retention of the ceniza-arena particles by the foliage of a variety of plant specimen for evaluating foliar contamination factors of these specimens. 2. Make measurements of the meteorological parameters (such as air temperature, relative humidity, surface wind speeds, and rainfall) and other independent related parameters (such as the particle size and amount deposited of the ceniza-arena fallout) coincident with the measurement of the contamination factors. 3. Obtain experimental data on the deposition patterns of the ceniza-arena and the dependence of the deposition patterns on the airflow patterns over the area of deposition. 4. Obtain experimental data on the contamination of people exposed to depositing particles. The information obtained led to the conclusion that experimental data could readily be obtained on the following subjects: (1) Evaluation of Procedures and equipment for sampling particle clouds; (2) Retention of silicate-base particles by foliage; (3) Particle deposition behavior in urban areas; (4) Particle redistribution behavior in urban areas due to traffic, wind, and rainfall; (5) Ingress of falling (or redistributed) particles through openings in structures; (6) Ingress of falling particles into ventilation sytems; (7) Particle fall velocities and wind dispersion coefficients; (8) Deposition patterns and rates of deposition of particles; and (9) Retention of particles by people, clothes, and equipment. The volcanic particles, except for being nonradioactive, were found to be similar to some characteristic types of fallout particles from nuclear explosions and were found to be deposited on both agricultural communities and urban communities; therefore, it was concluded that the situation in Costa Rica for obtaining information on the above subjects for civil defense application was nearly ideal. This conclusion was generally confirmed during the experimental phase of the project.
Source: 1

#969
Miller, J. M., and R. DePena. "Contribution of scavenged sulfur dioxide to the sulfate content of rain water." J. Geophys. Res., 77(30):5905-5916 (1972).

The rate of formation of sulfate ion in raindrop size distilled water drops was measured for partial pressures of SO_2 ranging from 10^{-6} to 4×10^{-3} atm. A model was developed based on the results and on the assumption that the rate of formation of sulfate is determined by the rate of the first dissociation of sulfurous acid and by the rate of oxidation of sulfite to sulfate. The results of the model agree with published data for the rate of solution of SO_2 at low partial pressures. The model was applied to rainout and washout of SO_2 by cloud and raindrops. The contribution of the sulfate formed by gaseous absorption to the sulfate content of rain water was calculated. This contribution is important in polluted areas, although it is not predominant. It is also shown that fog droplets, after absorbing SO_2 in relatively polluted areas, produce particles of cloud nucleus size by evaporation.
Source: 5

#1575
Miller, Paul Robert and Arthur A. Millecan. "Extent of oxidant air pollution damage to some pines and other conifers in California." Plant Disease Reptr., 55(6):555-559 (June 1971).

The incidence of oxidant air pollution damage was investigated on 16 native conifer species in California during a 3-year period. The most serious damage was to Pinus ponderosa, P. jeffreyi, P. coulteri, P. radiata and Pseudotsuga-macrocarpa in the south coast and adjoining portions of the southeast air basins including the Angeles, San Bernardino, and Cleveland National Forests. P. attenuata was slightly affected in the south coast basin. Suspected oxidant injury symptoms were also observed on P. contora, P. lambertiana, P. torreyana, Abies concolor, and Libocedrus decurrens. No injury was observed on P. sabiniana, P. monophylla, Juniperus occidentalis, Sequoia gigantea, and S. sempervirens. Choose-and-cut Christmas tree farms, utilizing mostly P. radiata, experienced significant oxidant injury. The potential for new, severe forest damage is located in the mixed conifer forests bordering the east side of the San Joaquin Valley air basin and also in scattered stands in the San Francisco Bay and north central coast air basins.
Source: 1

#837
Miller, V. L. "The Effect of Atmospheric Fluoride on Washington Agriculture." In: Air Pollution. Louis C. McCabe (ed.), New York, McGraw-Hill Book Co., Inc., Chapt. 11, p. 116-122 (1952).

A variety of studies of fluorides and vegetation are briefly reported. A new disease of the gladiolus Italian prune, characterized by brown, marginal leaf scorch and premature defoliation, is caused by industrial fluoride emissions. Fluorine scorch of gladiolus may be controlled by lime sprays under field conditions, and early results suggest that some varieties of gladiolus may serve as indicator plants in areas where fluoric effluents are a factor. Fluorosis of cattle in Washington was diagnosed, caused by ingestion of forage containing fluoride from air pollution. Extensive research is in progress on a number of possible causes of the ponderosa pine blight, including air pollution, climatic factors, insect damage, and fungus diseases; conclusive results are not yet available.
Source: 1

#618
Miller, V.L., R. K. Howell, and B.E. Caldwell. "Relative sensitivity of soybean genotypes to ozone and sulfur dioxide." J. Environ. Quality, 3(1):35-37 (Jan.-March 1974).

Twenty-one soybean genotypes were evaluated for resistance to ozone and 19 genotypes for esistance to sulfur dioxide in a greenhouse and a growth chamber. The genotype PI 157474 was most resistant to ozone, but ranked 14 in resistant to SO_2. York was most resistant to SO_2 and ranked fourth when subjected to ozone. Peking was least resistant to both phytotoxicants. Experimental conditions necessary to investigate inheritance of resistance to ozone were determined by fumigating soybean plants equally spaced in a growth chamber. Relative senitivity of each of the parents at several stages of foliar development must be established before classifying the progeny.
Source: 1

#1576
Ministry of Health & Welfare (Japan), Environmental Pollution Control Dept. "Yamagata-ken yoshinogawa ryuiki ni okeru kadomyumu kankyo osen ni kansuru koseisho no kenkai to kongo no taisaku." (Opinion of the welfare ministry with regard to environmental pollution by cadmium in the basin of the Yoshino River in Yamagata Prefecture and countermeasures to be taken). Translated from Japanese by Seizaburo Aoki, Japanese Language Translation Service, Funsawa, 15 p. In: Kadomyumu Kankyo Osen Taisaku (Countermeasures Against Environmental Pollution by Cadmium), 219-231 (March 1972).

Environmental pollution by cadmium in the basin of the Yoshino River in Yamagata Prefecture of Japan was studied. Samples were taken from water, subsoil, sol, crops, and meals (grains) in the river and its basin, and analyzed for cadmium, zinc, and lead concentrations. Evaluation of the concentrations showed thatthe river water, discharge water from mines and smelting plants, subsoil, and soil showed high concentrations of these metals. Drinking water, polished rice, unpolished rice, and meals, and the intake per day per adult person of cadmium, showed concentrations below the set standards. Periodic monitoring of Cd concentrations should continue, discharge water from the smelting plants should be overseen, and the area's water supply should be changed from the Yoshino River to the Mogami River.
Source: 1

#1577
Miroshnikova, A.T. and V.S. Nikolayevskiy. "Novyye biofizicheskiye metody diagnostiki gazoustoychivosti rasteniy." (New biophysical methods for determining the gas tolerance of plants). Uch. Zap., Perm. Gos. Univ., 256:197-210 (1971).

The possibility of using biochemiluminescence methods for studying the gas tolerance of plants in connection with determining admissible norms of atmospheric contamination was investigated. It was established that a quantometric apparatus with registry of phosphorescence under the influence of an excess quantity of a solution of potassium permanganate can be used for determining the quantity of oxidizable substances in plants, though the method requires further work. The intensity of electrochemiluminescence of a filtrate of green leaves of plants was found to be proportional to the damageability of them by acidic gases; and under the influence of chlorine, plants exhibited a change in electrochemiluminescence of the filtrate, correlating with gas tolerance. Phosphorescence was increased in tolerant species, whereas in nontolerant it was reduced. The nature of change in the fluorescence of the filtrate of leaves under the influence of chlorine, like the intensity of phosphorescence from undamaged leaves after photosynthesis (15 min or more) was found to characterize the degree of gas tolerance of plants, and the intensity of autolysis in homogenates of leaves was found greater in nontolerant species.
Source: 1

#1578
Mitsudera, M. "Kankyo no kanshi." (Monitoring of environment). Text in Japanese. Kankyo Sozo (Environ. Creation), 4(9):68-74 (Sept. 1974).

The amount of pollutants discharged has now exceeded the environments natural ability to purify itself. The effect of urbanization, is traced especially the degeneration of plants and animals in Tokyo. One of the methods of monitoring plants is remote sensing with multi-band photography and multi-spectroscanning. There is a correlation between the sulfur content of tee leaves and multi-bandphotograms on red pine trees with a correlation coefficient of-0.862.
Source: 1

#1260
Mitsuse, T. and Y. Yamada. "Tsuchi ni yoru taikichu issanka tanso no joka sayo ni tsuite." Report II. (Purification of carbon monoxide in atmosphere by soils).Report II . Japan Society of Civil Engineers, Tokyo, 4:274-275 (1974).

In loosely-packed and scattered soil, the decrease in carbon monoxide is proportional to weight of soil. With tightly-packed soil, the decrease is proportional to the exposed surface. Therefore, CO purification by soil can be calculated by unit weight of loosely-packed soil, and per unit of surface area of the tightly-packed soil. When soil is submerged in water, the volume of water affects the purification effect, i. e., the greater the depth, the less the decrease of CO. Water in which soil is mixed, or floating around, is capable of purifying CO. The same effect is produced when such water is filtered. Although the purification effect increases, when the same soil is used repeatedly for purification of CO, there is a limit, which depends on the type of soil. Natural soil releases carbon dioxide, the degree again depending upon the type of soil, but no clear correlation between the decrease of CO and the increase of CO_2 was established.
Source: 1

#1609
Miyake, Y. "Tabako no seiriteki hanten shogai ni kansuru kenkyu (dai 5 ho) ozon kanjusei to yochu asukorubinsan, gurutachion ganryo to no kanren." (Studies on physiological tobacco leaf spot (Part V). Relation between sensibility of tobacco leaf to ozone and its contents of ascorbic acid and glutathione). Utsunomiya Tabako Shikenjo Hokoku (Bull. Utsunomiya Tobacco Exp. Sta.), 23: 55-59 (Oct 1973).

To study the relationship between the leaf-damage of tobacco plants and the contents of ascorbic acid and of glutathione in the leaves when the plants were exposed to airborne ozone at the concentration of 40 pphm, two strains of Bel W3, S (highly susceptible to ozone) and R (moderately resistant to ozone) were exposed for 3 hr respectively 40, 60 and 80th day of transplantation. Judging from the leaf-damage on 16-18 position, the susceptibility of Bel W3-S to ozone was invariably higher than that of Bel W3-R, especially when exposed to ozone on the 60th day of transplantation. Generally, the

contents of reduced-type ascorbic acid and total ascorbic acid were higher in the Bel W3-R leaves than in the Bel W3-S leaves. The ratio of oxidized-type ascorbic acid to reduced-type ascorbic acid was higher on the 60th day of transplantation in both strains. The content of total glutathione was higher in the younger stage of growth of Bel-W3-S plants. Foliage application of reduced-type ascorbic acid and reduced-type glutathione, lowered the degree of leaf damage by ozone-exposure. The relationship of contents of glutathione and ascorbic acid to the nitrogen compouents and sugar components of tobacco leaves was discussed.
Source: 1

#1608

Miyake, Y., and Y. Uno. "Tabako no seiriteki hanten shogai ni kansuru kenkyu (dainiho). Oshokushu tabako no ozon shogai to tainai chisso kagobutsu to no kanren ni tsuite." (Studies on physiological tobacco leaf spot (II). Relationship between ozone leaf damage and nitrogenous compounds in flue cured tobacco leaf). Text in Japanese. Utsunomiya Tabako Shikenjo Hokoku (Bull. Utsunomiya Tob. Exp. Sta.), 11:7-13 (Nov. 1972).

Leaves from four tobacco varieties at the topping stage were fumigated with 40 pphm of ozone for 3 hrs to investigate the biochemical relationship between ozone leaf damage and nitrogenous compounds in flue-cured leaves. The leaves of ozone-susceptible varieties showed low levels of chlorophyll (a plus b) and insoluble nitrogenous compounds. Total glutathione content was higher in the ozone susceptible varieties than in ozone-resistant ones, whereas content of protein-thiol groups was lower in ozone-susceptible varieties. The contents of glutathione and protein-SH groups in tobacco leaves are concluded to play an important role in ozone leaf damage.
Source: 1

#1580

Miyake, Y., and Y. Uno. "Tabako no seiriteki hanten shogai ni kansuru denkyu (Daisanpo). Tabako Tainai no gurutachion nodo to ozon ni yoru seiri shogai hasseido to no kanrensei ni tsuite." (Studies on physiological tobacco leaf spot (III). Relationship between content of glutathione in tobacco leaf and ozone leaf damage). Text in Japanese. Utsunomiya Tabako Shinkenjo Hokoku (Bull. Utsunomiya Tob. Exp. Stn.), 11:15-22 (Nov. 1972).

Results are presented from studies investigating the relationship between glutathione content in tobacco leaf and ozone damage to the leaf. The topping stage of tobacco leaf growth appeared to be the most susceptible stage to ozone damage, with total glutathione levels at this stage being the highest. Ozone fumigation resulted in a lowering of the reduced glutathione in tobacco leaf, though at night the reduced glutathione returned to normal levels. The level of oxidized glutathione increased temporarily as a result of ozone fumigation, with oxygen uptake and glutathione patterns of the leaves showing a similar tendency. The results suggest an association between the content of glutathione and tobacco leaf respiration and the occurrence of ozone leaf damage.
Sourde: 1

#1579
Miyake, Y. and Y. Uno. "Tabako no seiriteki hanten shogai ni kansuru kenkyu (dai 6 ppo) Bel W3 no ozon ni yoru seiri shogai to kiko kaido tono kanren." (Studies on physiological tobacco leaf spots Part VI: Relationship between the physiological damage due to ozone and the stomatal aperture of the leaves of Bel-W3 strain). Utsunomiya Tabako Shikenjo Hokoku (Bull. Utsunomiya Tob. Exp. Stn.), 12:61-66 (Oct 1973).

The relationship between tabacco leaf damage due to ozone and the stomatal apeture was investigated. Leaf discs cut from two strains of tabacco plants, Bel W3-S (highly susceptible to ozone) and Bel W3-R (moderately resistant to ozone), were exposed to ozone-containing air at 50 ppm for 3 min and the appertures of the stomata were measured. After 60 days the stomatal aperture and the number of stomata were larger in the leaves of the Bel W3-S than in Bel W3-R. When the plants were exposed to light after being kept in the dark, the rate of stomatal opening was slower in Bel W3-S than in Bel W3-R and the time required to fully open the stomata was longer in the S strain than in R. At the same level of ozone exposure, the leaf damage was heavier in S than in R. Phenyl mercury acetate and D-sorbitol induced the stomatal closing of the leaf-disc when applied in an aquerous solution during ozone exposure and reduced ozone damage to the leaf. Foliar application of phenyl mercury acetate and D-sorbitol is an effective method for reducing damage due to ozone of tobacco plants.
Source: 1

#1259
Miyamoto, S., R. J. Prather, and H. L. Bohn. "Nitric oxide sorption by calcareous soils: II. effect of moisture on capacity, rate, and sorption products." Soil Sci. Soc. Am. Proc., 38(1):71-74 (Janurary-February 1974).

The effect of moisture on capacity, rate, and sorption products was investigated for nitric oxide sorption by calcareous soils. The NO sorption capacity at room temperature increased with the presence of moisture in an air plus NO stream (1.5% NO by volume) and/or in the soils. The largest increase, up to 10-fold or approximately to the acid-titratable basicity of soils, occurred when NO and water were sorbed simultaneously by initially dry soils from a moist air (95% humidity) plus NO stream. The sorption rates were proportional to the unused portion of the capacity, the rate constants ranging from 0.02-0.03/min for NO and 0.01-0.015/min for H_2O under simultaneous sorption. Initially moist soils sorbed NO from a dry air (loss than 5% humidity) plus NO stream until the soils dried. The rate of NO sorption slowed at initial soil water suctions less than approximately 1 bar. Sorbed NO was recovered as nitrate and reacted with the basicity in moist soils. Less than 20% of the sorbed nitrogen was lost upon heating at 105C for 24 hr. Data is applicable to controlling waste gases by solid sorbents.
Source: 1

#1610
Miyamoto, S., J. Ryan and J.L. Stroehlein. "Effects of SO2 on calcerous soils." Sulphur Inst. J., 10(2):14-15 (Summer 1974).

While atmospheric sulfur dioxide concentrations of 0.1-0.2 ppm or less do not generally injure plants, high concentrations can cause damage. On the other hand, calcerous soils benefit from and are frequently treated with sulfur compounds to improve their cropping properties. Since there were indications that SO2 may have a beneficial effect on calcerous soils and that the soils have a high capacity for adsorbing SO2, experiments were conducted on the effects of low and high amounts of SO2 on two soils in greenhouses. Low concentrations of SO2 (equivalent to 2 tons SO2/ha-30 cm) increased vegetative growth as effectively as sulfuric acid in both soils. Ferrous sulfate increased vegetative growth in the Gothard soil, but not in the Cave soil. Gypsum had no effect. When large amounts of SO2 (up to 700 tons/ha-m) were injected into calcerous soils, no significant adverse effect occurred. Increased vegetative growth compared with untreated soils did occur. The total plant uptake, but not necessarily the concentration, of iron, manganese, zinc, and phosphorus increased. The pH decreased within an alkaline range in both soils. The high adsorption rate of the calcerous soils make them useful for disposal of SO2, while the waste SO2 can be used to improve the soil.
Source: 1

#1258
Miyamoto, S., A. W. Warrick, and H. L. Bohn. "Land disposal of waste gases: I. Flow analysis of gas injection systems." J. Environ. Quality, 3(1): 49-55 (Jan. - March 1974).

The steady state flow of gases in soils is analyzed mathematically from the view of land disposal of waste gases by absorption. Gas injection systems considered include ditches, buried pipes, and wells. The systems are compared on the basis of how effectively the power is used (power efficiency) and how uniformly the gas is distributed through soils (uniformity). Often the two criteria are in conflict, and systems giving a high power efficiency result in low uniformity. Gas injection by buried porous pipes appears to be more advantageous than ditch or well systems.
Source: 1

#1257
Miyamoto, S., A. W. Warrick, and R. J. Prather. "Land disposal of waste gases, III: sorption patterns from buried gas injection pipes." J. Environ. Quality, 3(2): 161-166 (April-June 1974).

The advancement of sorption fronts resulting from the injection of reactive gases into soils through buried porous pipes is analyzed mathematically and verified experimentally with small scale laboratory models. The sorption front advances in ellipsodial patterns with faster rates above the pipes for a homogeneous profile. The reacted portion of soil when the front first intersects the ground surfaces is larger for corrugated surfaces than for plane sur-

faces. The corrugated surface is chosen with the highest elevation point directly over the injection pipe, the lowest point midway between. When a shallow sorptive layer overlies a nonreactive material, the shape of the front is not circular but extends towards the midpoint between parallel pipes where the most water would infiltrate. The concentration of reactants in the outflow increases sharply as the front passes a part of the ground surfaces. The sorption fronts determined experimentally by injecting a dry air and nitrogen dioxide mixture into a small soil tank agreed well with the predicted positions based on an instantaneous reaction. The theoretical procedure as presented is useful for predicing the mean position of the sorption front as a function of gas discharge (or time) for a given buried pipe injection system. Although the results compared well with the fast reacting nitrogen dioxide used in the experiment, the analysis is probably inadequate for slower-reacting gases. At the same time, the relative advantages of the various geometries should remain valid even for slower reaction rates.
Source: 1

#951

Miyoshi, T., Y. Jinzo, Y. Kanashima, J. Machida, and F. Shimomura. "Annaka chiku soyochu no jukinzoku no yurai keiro--dojo kara to taiki kara to no kaiseki." [The sources of heavy metals in mulberry leaves in Annaka--analysis of the sources from soil and air]. Proc. Symp. Japan Soc. Air Pollut, 13th, p. 226 (Nov. 7-9, 1972).

The mulberry leaves grown south of Annaka city and the Toho Zinc Refinery contain levels of cadmium and zinc that may be dangerous to silkworms. Experiments were conducted to see the exact source of these toxic heavy metals. Flower pots were installed at various polluted and unpolluted locations, and the unpolluted soil of the sericultural Experiment Station and the soil of the polluted location in Annaka were compared for growing mulberry seedlings. The plants that were grown in the soil of the unpolluted area showed a different metal content in the leaves depending on the atmospheric content of metals, showing that the air pollution definitely played an important role in the pollution of mulberry leaves. Those grown at the Experiment Station had 0.10 ppm of Cd and 23 ppm of Zn; using the same soil, those grown in the polluted area of Annaka had 1.70 ppm of Cd and 343 ppm of Zn. However, using the soil of the polluted area and grown in the polluted atmosphere, the maximum content of Cd was 3.58 and of Zn was 1050 ppm in the mulberry leaves.
Source: 1

#1135

Mizuno, Akira adn Hidehiko Midorikawa. "Taiki osen no jumoku ni oyobosu eikyo narabini ryekkaboku ikusei ni kansuru kenkyu." (Study on the effects of air pollution on trees and the growth of trees). Atahi Prefecture (Japan), Forest Experiment Station, 70 p. (Jan. 1973).

The effects of air pollutants, especially of sulfur oxides, on plants were investigated on the conditions of trees in forests, parks, and green areas in Nagoya, and experiments were given on newly planted trees in polluted and non-

polluted areas. Twenty locations in forests and 50 locations in parks and green areas with a 30 km radius from the Nagoya port, and black pines, cherry trees, gingko trees, linden, and garden phlox were examined. According to the measurements taken by the lead dioxide method, pollution spreads northward in summer by a southerly wind, and spreads in the opposite direction in winter. Gingko takes in a large amount of sulfur between spring and fall. The specimens from 70 locations showed that the S content in the leaves was greater in proportion to the closeness of the location to the center of pollution. A definite correlation was noted between the S content in leaves and the atmospheric content of sulfur trioxide, except in the case of garden phlox. The degree of growth damage of the newly planted pine trees and the S content in leaves and the tree damage was not clear; but in several areas, necrosis, chlorosis, and tip burn seemed to indicate the damage from air pollution, and the S content in these leaves were among the highest.
Source: 1

#838
Mohamed, A.H. "Chromosomal changes in maize induced by hydrogen fluoride gas." Can. J. Genet. Cytol (Ottawa), 12(3):614-620 (Sept. 1970).

Twelve corn plants were placed in growth chambers and fumigated for four to ten days with about 3 micrograms/cu m of hydrogen fluoride (HF). Following treatment, the plants showed no visible symptoms of fluoride injury. However, microsporocyte smears from the plants revealed chromosomal abberations that included asynaptic regions, translocations, inversions, and bridge plus fragments or fragments by themselves. These abnormalities are considered due to the physiological effect of HF causing chromosome to become sticky and/or to the occurrence of chromatid breakage followed by reunion to form structural changes. These findings indicate that HF is a mutagenic agent.
Source: 1

#529
Molenda, T. "Metodyczne zalozenia szachwzinia strat w zakresie poxagospodarczych funkcji lasu." (Procedural assumptions of the appraisal of losses in non-economic functions for forest. Damages, industrial air pollution). Sylwan, 117(9):12-19 (September 1973).

Technical projects of the construction of industrial plants in their assumptions neglect losses incurred in natural environment, particularly in coniferous forest due to air pollution by industrial gasses, mainly so by sulphur dioxide. As a reason of this negative phenomenon for national economy procedural inadequacies in the calculation of protective and cultural functions of forest are usually pointed out.

Under the planned economy in which both forests and industry constitute socialized assets, the system of economic calculus of the whole industrial damage in the substance of forest resources, both in commercial and in protective forests, may be based on following assumptions corresponding with the concept of social interest.

Claim of compensation from forest authorities due to industrial damage in forests is obvious when the relationship between the cause (industrial exhalations) and result (damage in forest) concerns the highest levels of emergency. In this connection author suggests the introduction of the concept of two emergency zones to the economic calculus of losses. They are 1) zones of lethal emergency due to exceeding the individual limit of the concentration of toxic exhalations of increasing the collective pollution of air by industrial plants situated in vicinity what leads to a rapid drying of stands and their premature harvest in total or in most part; 2) zones of harassing emergency which during the existence of an industrial plant impairs the production ability of forest at least by 50% when compared with the potential to be attained under conditions of no emergency.

Forest losses due to the negative impact of industry (development of production forces) upon forests is appraised as a complex impairment of the function of purposes of forest resources (productive, protective in relation to nature, and cultural in relation to man and his increasing needs).

Initial basis of the economic calculus of losses is provided by:

- principle of the unity of purposes of forest resources,
- potential productivity of the forest evaluated,
- time scope of the existing and expected losses,
- accepted zones of emergency,
- principle of multiplicityof the productive function as an objectified measure and equivalent of protective and cultural functions of the damaged forest.

Following values of multiplicity coefficients are suggested in the appraisal of losses in protective and cultural functions:

- in commercial forests at least as 1:1,
- in protective forests in agricultural regions as 1:10,
- in national parks, reserves, and other protective forests as well as in forests around great municipal and industrial agglomerations the multiplier equivalent to a quotient of the destination density of population in the strongest in this country muncipal and industrial macroregion to the national average population density in a perspective of the existence of industrial plant.

Objects of natural environment particularly valuable for science and culture recorded in rolls of natural monuments of the country and in world, are by law excluded from possible threat and in the case of inevitable liquidation are subjected to individual evaluation by best experts and require the acceptance (approval) by highest state authorities.
Source: 2

#619
Monden, Masaya, Yuzuru Yumiba, and Akira Tanaka. "Taiki osen ni yoru shoku-butsu higai." (Plant damage by air pollution). Anzen Kogaku (J. Japan Soc. Safety Eng.), 10(4):189-196 (Aug 1971).

Plants were exposed to sulfur dioxide, chlorine (hydrogen chloride), fluorine (hydrogen fluoride), ozone, peroxyacetyl nitrate (PAN), and nitrogen oxides (nitric oxide and nitrogen dioxide) and observed for symptoms of plant damage. The effects of exposure to sea winds, frost, and SO2 appeared as round spots around the leaf edge or between the leaf veins. The spots increased with strong sunlight. Damage due to HCl, large irregularly shaped spots, was limited to small areas of the leeward side, but was sometimes severe. Symptoms of damage by HF were similar to those of C12; the damage and healthy parts of the plant were clearly distinct with HF damage. Apricot trees and gladiolus were very sensitive to HF exposure and affected by concentrations of 0.1 ppb and less. The HF content of the damaged leaf attained 50%. Damage due to ozone, caused by factory and automotive exhaust gases, was most severe in June and July. Among the nitrogen oxides, NO2 and NO caused most damage and inhibited plant growth. PAN, the product of a photochemical reaction, caused reduction of the photosynthetic function when damage was chronic; in cases of acute damage, it affected the protoplasm and produced cavity formations on leaves.
Source: 1

#1882
Monteith, J. L. (ed.) Vegetation and the Atmosphere, Volume 1, Principles. New York, Academic Press, 278 p. (1975).

To produce Vegetation and the Atmosphere, a number of micrometeorologists and ecologists were asked to assess the state of knowledge in their subject and the extent to which physical and biological ideas had become usefully integrated. The material which they produced has been divided between two volumes, the first dealing mainly with basic principles and the second with case studies of crops, forests, and ecosystems. The first chapter of Volume 1 is a short general introduction which reviews and contrasts the concepts and methods of ecology and micrometeorology. The four chapters which follow deal with transfer processes: the transfer of radiant energy in plant communities is discussed by Ross; heat, mass and momentum transfer are treated by Thom as closely related processes; Rutter deals with the interception of rain by vegetation and the passage of water through the plants from the root system to the leaves; and Chamberlain describes the aerodynamics of small particles such as pollen and spores. In Chapter 6, Waggoner shows how some of the concepts developed in previous chapters can be drawn together in mathematical models for the growth of vegetation, or its use of water, or the spread of disease. Finally, Szeicz discusses the calibration and use of a range of instruments for measuring the environment of plants and their response to environmental factors.
Source: 8

#226
Mooi, J. "Onderzoek naar de gevoeligheid van houtige gewassen voor SO_2 en HF." (Investigation of the susceptibility of woody plants for SO_2 and HF). Text in Dutch. Groen, 1972:1-12 (Jan. 1972).

The equipment for fumigation of woody plants in the field developed by Spierings was improved by mounting feelers to the fumigation gun in order to measure climatic conditions. The data from these feelers is registered automatically on instruments situated in a van and worked out by a computer. The equipment is used for short time fumigations in the field. Short time fumigations were also carried out in the laboratory. The data and symptoms of damage to the trees and shrubs caused by low concentrations of sulfur dioxide and hydrogen fluoride are discussed. In a fumigation experiment with a concentration of 2.41 ppb HF applied during 4 months, trees and shrubs showed a great difference in susceptibility to and capacity for uptake of HF.
Source: 1

#100
Moorby, J., and H. M. Squire. "The loss of radioactive isotopes from the leaves of plants in dry conditions." Radiation Botany, 3:163-167 (1963).

When radioactive isotopes are applied to the foliage of plants varying amounts of the isotopes may be subsequently lost from the plants when they are kept in dry conditions. Losses appear to be greatest in good growing conditions in the summer. It has been possible to demonstrate the transfer of strontium 89 to uncontaminated plants and to trap it in air filters. It is suggested that materials might be lost from leaf surface in association with small wax particles, but no conclusive evidence is available.
Source: 7

#839
Morgan-Huws, D.I., and F.N. Haynes. "Distribution of Some Epiphytic Lichens Around An Oil Refinery at Fawley, Hampshire." In: Air Pollution and Lichens. B.W. Ferry, M.S. Baddeley, and D.L.Hawksworth (eds.), Toronto, Toronto Univ. Press, Chapt. 5, p. 89-108 (1973).

The distribution of some epiphytic lichens around an oil refinery at Fawley, Hampshire (England) was investigated in 1966. There was a direct relationship between the annual average sulfur dioxide levels and the zonation of the lichen vegetation of oak trunks. There was no evidence of any effect of relative humidity. The different levels of tolerance to SO_2 for the eleven species investigated are similar to those found in a more general survey of the lichens of oak trunks in the southwest of Hampshire, and in other parts of England and Wales. The influence of SO_2 around urban areas where it is typically accompanied by much higher smoke levels is evident implying that smoke may not be a factor contributing to the limitation of the lichen vegetation in such areas.
Source: 1

#968
Mortland, M.M. "Nitric oxide adsorption by clay minerals." Soil Sci. Soc. Amer. Proc., 29:514-519 (1965).

Nitric oxide was found to be chemically adsorbed on montmorillonite and nontronite when the exchange complex was saturated with certain transition metal ions. Infrared data showed a number of reactions depending on the nature of the saturating ion including: (i) coordination of NO as the mono or dinitrosyl complex; (ii) formation of N_2O; (iii) formation of $(NO)^-$. The NO molecule was able to penetrate the interlamellar regions of Co-montmorillonite or Co-nontronite. On all other systems, apparently only surface adsorption occurred. When air was admitted, all surface-adsorbed NO was immediately oxidized, but interlamellar NO decreased at a rate apparently dependent upon the diffusion of NO to the clay mineral surface. A produce of oxidation was found to be coordinated nitrite.
Source: 5

#59
Motto, H. L., R. H. Daines, D. M. Chilko, and C. K. Motto. "Lead in soils and plants: its relationship to traffic volume and proximity to highways." (Presented at the American Chemical Society Annual Meeting, 157th, Division of Water, Air and Waste Chemistry, Symposium on Air Conservation and Lead, Minneapolis, April 1969.) Environ. Sci. Technol., 4(3):231-237 (March 1970).

The lead content of grasses and soil samples along highways was determined. The results show that there is surface contamination of the plants and soils with lead. In addition, five crops - carrots, corn, lettuce, potatoes, and tomatoes were grown at three distances from highways having various traffic densities. These same crops were grown in the greenhouse in soil from the surface six inches of field plots and in acid-washed sand to which soluble lead was added. Analysis of plants grown in the field revealed that the highest lead levels were associated with the leaves with lower levels in the roots. These same plants grown in the greenhouse exhibited lower levels in the leaves relative to the roots. The results indicate lead was absorbed through the root system in the greenhouse with some translocation to other parts of the plant. The overall results showed that the lead content of plants and soils increased with increasing traffic volume and decreased with increasing distance from highways. Most of the lead accumulated was within 100 feet of the highways. The edible portion of carrots, corn, potatoes, and tomatoes contained the lowest amounts of lead and showed the least effect of increased lead supply. The edible portion of lettuce contained a larger amount of lead. Similar relationships of lead in air, plants and soils with traffic volume and distance from highways indicate a common source of lead, the gasoline consumed by motor vehicles.
Source: 1

#1201

Moura, J. de, D. le Tourneau, and A.C. Wiese. "The response of potato (Solanum tuberosum) Tuber phosphoglucomutase to fluoride." Biochem. Physiol. Pflanzen, 164(3):228-233 (1973).

Most research on the effects of fluoride ions in plants has been concerned with aerial parts. For observation of the response to underground tissues, potato tubers were fluoridated. At the same time in vitro studies on the effect of fluoride on phosphoglucomutase (PGM) from untreated tubers were made. Protein content was measured by Enddel s method. Najjar s procedure was modified for enzyme activity tests. Phosphoglucomutase was partially purified from potato tubers and was relatively insensitive to the presence of fluoride ions in vitro. The enzyme was activated by magnesium (++) but not by manganese (++) ions, and was not inhibited by fluoride (-) in the presence of Mn (++). The enzyme was relatively insensitive to F(-) when Mg (++) was present, but the amount of inhibition was dependent on the level of Mg(++) and, more importantly, on the order of mixing the reagents prior to the assays.
Source: 1

#1614

Mudd, J.B. "Biochemical effects of peroxyacetyl nitrate and ozone." Council of Euorope, Committee of Experts on Air Pollution, Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 161-166 (April 22-27, 1968).

The difference in the chemical activity of two plant damaging pollutants, ozone and peroxyacetyl nitrate, with a relatively well defined group of porteins and amino acids was studied. The main reaction of PAN with proteins is with the sulfhydryl group of the cysteine residue. Disulfide bonds are relatively unaffected. These is some oxidation of methionine to methionine sulfoxide, but all other amino acids are resistant. Oxidation of amino acids by ozone is much less specific. Cysteine, methionine, tryptophan, histidine, tyrosine, phenylalanine, and cystine are all oxidized. Consequently, some enzymes such as ribonuclease are resistant to PAN, but susceptible to inactivation of ozone.
Source: 1

#540

Mudd, J. B. "Biochemical effects of some air pollutants on plants." Adv. Chem., Ser., 122:31-47 (1973).

The properties of the air pollutants sulfur dioxide, nitrogen oxides, peroxyacyl nitrates, and ozone are considered from chemical, biochemical, and physiological points of view. Physiological observations cannot demonstrate the chemical mode of toxicity. Chemical and in vitro biochemical structure may be irrelevant at the physiological level. Consideration of all three approaches indicates which hypotheses of toxicity are more plausible and suggests new areas of investigation.
Source: 2

#1613
Mudd, J.B., T.T. McManus, and Alpaslan Ongun. "Inhibition of lipid metabolism in chloroplasts by ozone." International Union of Air Pollution Prevention Assoc., 25 p. (1970). Presented at the International Clean Air Congress, 2nd, Washington, D.C., Paper MB-33B (Dec 6-11, 1970).

The metabolism of carbon 14-acetate and carbon 14-acetyl-coenzyme A by spinach chloroplasts is inhibited by ozone. The synthesis of lipid is inhibited much more than the synthesis of nonvolatile water soluble compounds. These results correspond exactly to inhibition by sulfhydryl reagents. Amino acid analysis of the protein of ozone treated chloroplasts showed no detectable change, but the method of analysis was not suitable for analysis of cystein, methionine and tryptophan. Direct measurement of sulfhydryl groups of the chloroplast showed that sulfhydryl groups reacted with the ozone. Fatty acid analysis of the ozone treated chloroplasts showed no detectable change, but measurement of one of the expected products of oxidation, malonaldehyde, showed it to be present. Treatment of linoleate in aquerous solution with ozone yielded malonaldehyde, and hydrogen peroxide. In the presence of gluthione the formation of malonaldehyde is inhibited less than 5%,but no peroxide is detectable. Glutathione is oxidized under these conditions. Comparable results were obtained with oleate. It is concluded that though ozone may inhibit sulfhydryl requiring enzymes, at least two modes of toxicity are possible: direct oxidation of the sulfhydryl groups by ozone, and primary reaction with unsaturated fatty acids and secondary reaction of the hydrogen peroxide produced with sulfhydryl groups.
Source: 1

#228
Mueller, P. K., and R. L. Stanley. "Origin of lead in surface vegetation." California State Dept. of Public Health, Berkeley. Air and Industrial Hygiene Lab., National Air Pollution Control Administration Contract 86-68-35, AIHL Rept., 87. 15 p. (July 1970).

A model is presented for determining the relationship of airborne lead and soil lead concentrations to lead concentrations in pasture grasses. The major portion of atmospheric lead is derived from combustion of leaded gasoline and from fumes and dusts of industries using lead. Soil may be contaminated with lead by aerial fallout, industrial wastes, pesticides, fertilizers, and agricultural minerals. Soil composition and its acidity are important factors in whether or not lead will be available for plant uptake. On the basis of several published studies, it is concluded that not more than 15 micrograms pb/g dry weight in forage crops is due to the uptake of lead from soil even at soil lead contents up to about 700 micrograms/g and possibly 3000 micrograms/g. Amounts of lead in herbage substantially greater than 15 micrograms/g are therefore due to aerial fallout. The ratio of lead in herbage to the rate of lead fallout was reported previously as a constant of 50 sq m days/kg herbage. This model was applied to a typical situation in which grass lead content of pastures toxic to horses was greater than about 80 micrograms/g, top soil lead contents averaged about 300 micrograms/g, and the suspended particulate lead concentration averaged about 0.5 micrograms/cu m.
Source: 1

#347
Mukammal, E.I., C.S. Brandt, R. Neuwirth, D.H. Pack, and W.C. Swinbank. "Air pollutants, methodology, and plant injury." World Meteorological Organization, Geneva, Switzerland, Commission for Agricultural Meteorology, WMO-TN 96, WMO-No. 234.TP.127, 73 p. (1968).

The problem of air pollution injury to agriculture and the present state of knowledge is reviewed in order to assist meteorologists and others concerned in seeking means of preventing or controlling the extent of injury. The source of various contaminats and their chemical reactions in a contaminated atmosphere are examined in detail. The variations in the susceptibility of plants to air pollution damage as related to meteorological and other factors in the plant environment are described. These factors, many of which exert their influence through their effect or stomatal movement, include light, nutrition, exposure, relative humidity, and temperature. The recognizable symptoms of air pollution injury are discussed and suggested for identifying the causative agent and recognizing similar symptoms produced by other disorders are given. A section on air pollution meteorology states that knowledge of the atmosphere's ability to transport and dilute contaminants cannot be applied to air pollution problems without concurrent consideration of pollutant emissions and the biological sensitivity and response characteristics of certain plants. The effects of surface configuration on diffusion, to vertical and horizontal turbulent diffusion, atmospheric transport, research problems, and meteorological applications to air pollution problems are discussed. Present and possible future programs in the prediction of pollutant concentration, air pollution potential, and pollution damage are reviewed; the general principles involved in collecting and analyzing air samples to determine the nature and concentrations of pollutants are outlined.
Source: 1

#620
Mumford, R.A., H. Lipke, D.A. Laufer, and W.A. Feder. "Ozone induced changes in corn pollen." Environ Sci. Technol., 6(5):427-430 (May 1972).

The distribution and composition of pollen histones were monitored during the course of ozonation in vivo in experimental studies of corn pollen. Free amino acids increased 50% after exposure to 3 pphm of ozone. Higher levels further enhanced amino acid and peptide accumulation and inhibited germination 40-90%. Total alpha-amino N, free amino acids, and ethanol-soluble peptides increased in proportion to ozone exposure. Amino acid accumulation was greatest for alphaalanine, glutamic acid, and proline. Reducing and neutral sugars bound to ethanol-soluble peptides decreased. The tier or composition of the sulfur-containing F3 histone did not change. The data suggested that ozone induces the autolysis of structural glycoproteins and stimulates amino acid synthesis. (Author abstract modified).
Source: 1

#227

Munshower, Frank Forrest. "Cadmium compartmentation and cycling in a grassland ecosystem in the Deer Lodge Valley, Montana." Montana Univ., Missoula, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 114p. (June 1972).

Distribution, compartmentation, and transfer of cadmium was studied in a grassland ecosystem where airborne cadmium from a zinc smelter has accumulated for approximately 50 years until permanent closure in 1969. Thus, it was possible to study the cadmium cycle under discontinued contamination conditions. The cadmium content in plant and animal tissue samples was analyzed by atomic absorption spectrophotometry. The soil reservoir of introduced Cd is restricted to the top 2-5 cm, is geographically distributed in relation to the smelter and prevailing winds, and normally is not transferred to lower soil horizons. This indicates that the only probable routes of Cd exit from this ecosystem will be by surface erosion or by cropping, and not by leaching from the soil. Analyses of plants grown in controlled Cd concentrations in nutrient solutions and soil cultures, and of plants collected in the field, established that Cd was absorbed and translocated by plants in a predictable manner. Plant Cd concentrations are a function of the Cd concentration of the root medium, time of collection during the growing season, and species. Grasshopper Cd concentrations, and the liver and kidney Cd concentrations of cattle, swine, and columbian ground squirrels, demonstrated Cd accumulation above plant Cd levels as a function of the animal's age. The presence of Cd in the kidney of red fox, badger, and weasel documented Cd transfer from herbivores to carnivores. A mathematical model of the ecosystem was developed depicting the system as a closed, self-contained unit. Concentrations and quantities of Cd in each ecological compartment were derived in terms of the Cd concentration at the lower trophic level, life span of the organism, and its biomass on an area basis. The half-life for the introduced Cd in the grassland ecosystem appears to be in excess of 1000 years, and shorter in cultivated lands.
Source: 1

#1731

Munshower, F. "Distribution and compartmentation of cadmium in an arid grassland ecosystem." (Presented at the American Institute of Biological Sciences Meeting. Minneapolis. 20 p.) (Aug. 29, 1972).

The distribution of cadmium in soils, plants, and animals and the movement of Cd through the food chain from soil to plants to herbivores was studied between 1969 and 1971 in the Deer Lodge Valley of Montana. This valley has been polluted by emissions from the smelter complex at its southern end for over 80 years. Soils, flora, and fauna were sampled at different distances from the smelter. Heavy Cd pollution occurred within 2 to 3 mi of the smelter. Sites examined in this zone generally showed significantly lower soil pH values than other sites in the valley and greater Cd movement. Utilizing data collected in the study of Cd in plants and animals on the state prison pastures 15 miles from the smelter, a hypothetical ecosystem was constructed. Three compartments were recognized: soil, producers, and herbivores. A computer simulation of the ecosystem was developed. The model indicated that under the present grazing system, soil Cd levels will not be appreciably reduced for several hundred years and that if even small increments of Cd are added to the ecosystem along with the other heavy metals liberated by the smelter, the agricultural productivity of this valley will continue to be degraded.
Source: 1

#1615
Munshower, Frank F. "Biotic monitoring of the effect of power plant stack emissions on the range resource in southeastern Montana." Presented at the Air Pollution Control Association, Annual Meeting, 67th, Denver, Colorado, Paper 74-5(June 9-13, 1974). Preprint, Air Pollution Controll Association 14 p. (1974).

Biological monitoring can be used to determine the effects of power plant and other stationary source emissions on the ecosystem. A study was undertaken in southeastern Montana to determine the effect of trace elements (zinc, copper, iron, lead, cadmium), sulfur, and fluoride on the surrounding area. Trace element analyses of soils, plants, and animal were integrated with ecological investigations of the dominant plant communities. Low levels of fluoride occurred in plants and animals. Sulfur levels in plant tissues were 0.1-0.3%. Sulfur concentrations of 0.18% occurred in late summer pasture grasses, decreasing to 0.14% in cured winter grasses. Iron concentrations were normal (50-500 ppm) in all plants examined; concentrations of zinc and copper were below normal; lead and cadmium concentrations were less than 3 ppm and less than 0.3 ppm, respectively, in grasses. Visible sulfur damage occurred only on one pine within 1 mi of the power plant site. This study is the first attempt by a private utility in the area to provide advance warning of environmental degradation in the area surrounding a power plant.
Source: 1

#1970
Murphy, C. E. Jr., T. R. Sinclair, and K. R. Knoerr. "A model for estimating air pollutant uptake by forests: calculation of forest absorption of SO_2 from dispersed sources." (Presented at Conference on Metropolitan Physical Environment, Syracuse, New York, August 25-29, 1975).

The computer model presented in this paper is designed to estimate the uptake of air pollutants by forests. The model utilizes submodels to describe atmospheric diffusion immediately above and within the canopy and into the sink areas within or on trees. The program implementing the model is general and can be used with only minor changes for any gaseous pollutant. To illustrate the utility of the model, estimates are made of the sink strength of forests for SO_2. The results agree with experimentally derived estimates of SO_2 uptake in crops and forest trees.
Source: 8

#1616
Musche, R. "Bleigehalte in Lebensmitteln." [The lead concentration in food]. In: Blei und Umwelt. Kommission fuer Umweltgefahren des Bundesgesundheitsamtes (West Germany), Arbeitsgruppe Blei. p. 58-61 (1972).

The lead concentrations measured in basic food (e.g., milk 0.01 to 0.59 mg/l and eggs 0.02 mg/l) and in prepared food are listed in tables. The lead-containing waste gases in the atmosphere near highways lead to higher lead residues on the food. This lead leads mostly to an external contamination of plants. The quantity of lead residues on and in such plants drops with

increasing distance from the highways, the difference of the lead which can be removed by washing and the residual in the plant drops too. To give an example, the lead concentrations on unwashed leaves growing 5 m from a highway in the Ruhr area fluctuated between 41.5 and 64.5 micrograms/g dry substance, in washed plants between 38.4 and 41.5 micrograms/g dry substances; at a distance of 10 m the concentrations fluctuated between 31.6 and 43 micrograms/g dry substance for unwashed leaves and between 34.8 and 40.8 micrograms/g dry substance for washed leaves. At 50 m, the concentrations dropped to between 18.5 and 37.9 micrograms for unwashed and to between 14.9 and 35.8 micrograms/g dry substance for washed leaves. The measurements were taken in 1964.
Source: 1

#621
Mutsuura, Tsutomu. "Yokohama-shi ni okeru kokagaku sumoggu ni yoru shokubutsu nasakubustsu higai ni tsuite." (Injury by photochemical smog as observed and reflected on plants in Yokohoma City). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):544 (Oct 1973).

Plant and produce damages by air pollution were investigated at 30 locations in Yokohama between April and October 1972 on 3575 specimens; 157 samples showed some form of damages. Red beets (69 samples) had 45.5% damage rate; 30 spinach samples had 24.6% damages; 12 radish samples had 13.3% damages. Of 49 species, 14 had damages. Other damaged produce included turnips, Chinese cabbage, scallions, green onions, soy beans, and other green vegetables. These investigations were made on days of high oxygen concentrations ranging between 0.17 and 0.37 ppm. The effectiveness of fudanso (red beet) as a plant indicator was examined. The seeds were planted on July 25, and investigations were made between Aug 20 and Oct 20, and 60 spots covering 3.3 sq m. Six inspections were made on 315 samples, of which 98 showed some form of damages (31.1%) ranging from silvering on the back of the leaves to necrosis on both sides of the leaves. Red beet is highly susceptible to photochemical smogs, showing various types of damages by ozone and peroxyacetyl nitrate on the same specimens. Being a biennial plant, it permits a long-term observation.
Source: 1

#840
Nakagawa, Y., S. Matsuda, M. Hara, T. Koyama, and K. Takada. "Uwagusuriga-wara seizo kojo haigasu chu fukkabutsu ni yoru shokubutsu higai ni tsuite." (On damage to plants by fluorides in exhaust gas from tile manufacturing factory.). Text in Japanese. Hyogo Prefecture, Kobe (Japan), Environmental Sci. Inst., Rept. 2, p. 11-16 (Feb. 1971).

Crop damage occurred in the limited vicinity of gravel manufacturing plants in Hyogo Prefecture. The material for the tile contained fluorides, and damage to the corn and rice plants was chiefly the withering of the lead. Fluorides in the material clay, exhaust gas from the firing, the atmosphere around the factories, and the damaged plants were examined. Fluoride in the material clay was 296-306 ppm. About 30% of the fluoride in the clay volatilized during baking process. Also, the fluoride in the baked tile was at 208-214 ppm and in the exhaust gas was 1.7-4.4 ppm. Fluoride was

0.020-0.043 ppm in the environmental atmosphere, 54.3 ppm in the injured carnations, and 179.3 ppm in onions. The metal content in the exhaust gas analyzed, since the pigment used with about 80% of the manufactured tiles was copper oxide. The copper volatilizing during the baking process was measured as 10.6-66.8 microg/N cu m.Assuming it becomes diluted to 1 to 200 by atmospheric dilution (about 200 m away from the source), the density will be about 0.05-0.34 microg/N cu m, which can hardly affect plants. Unlike lead, copper does not accumulate in living tissues, so it does not cause chronic poisoning. Total sulfide in the stack gas was estimated at 4.8-5.9 ppm. Taking into account the dilution of sulfide by atmospheric diffusion the diversity is too low to adversely affect the plants. Therefore, the primary cause for damage to the plants was fluoride. However, possible geometric or arithmetric effects of various air pollutants may have to be further studied in connection with plant damage.
Source: 1

#841
Nakagawa, Y., S. Matsuda, M. Hara, T. Koyama, and N. Takada. "Yuyakugawara seizo kojo haigasuchu fukkabutsu ni yoru shokubutsu higai ni tsuite." (Casualties in plants by fluorides in exhaustive gas of glazed tile manufacturing factory). Hyogo-ken Eisei Kenkyusho Kenkyu Hokoku (Rept. Environ. Sci. Inst. Hyogo Prefect.), 2:11-17 (March 1971).

The cause of crop damage around a glazed tile manufacturing factory was determined by a survey of raw materials, fuel exhaust gas, environmental air, and damaged plants. During the period from May to August 1969, two ceramics with two tunnel kilns (the amount of exhaust gas per one tunnel kiln was 2700 2800 N cu m/hr) were tested. The change in fluorides in the tiles by calcination was measured and 296 306 ppm of the fluorides were found before the calcination and 208 214 ppm after it. The volatilizing amount of fluorides in the exhaust gas was about 45 ppm. On the other hand, the amount of fluorides contained in the exhaust gas in the fire flue was 1.7 4.4 ppm. This was perhaps caused by the condensation and adhesion of produced fluorides in the remaining heat kiln and in a fire flue. According to the JIS (Japanese Industrial Standard) K 0105 analysis method, the amount of fluorides in the exhaust gas was 0.020 0.043 ppm. Also, according to the Lime Treated Filter Paper method by Miller, the highest value in the place where the damage was the most distinctive was 258 micrograms F(-)/100 sq cm/ 3 days. The damaged plants included carnations, moist-land rice plants and onions. When the fluorides in the leaves were compared with those in healthy leaves, they showed: in carnations, where the amount of fluorides was the highest, the value of the damaged leaves was 52.3 ppm and that of the control leaves was 22.4 ppm; for the onions, the result was 42.1 ppm in the control leaves and 52.3 ppm for damaged leaves; for bamboo grass growing near the kilns, the amount of the fluorides was more than 12 times that of control leaves. Also, research was made on copper and sulfur oxides, and the obtained value was small in both cases. So the damage to crops is considered to be due to the fluorides.
Source: 1

#1617

Nakagawa, Yoshihiro, Hidekatsu Mitsugi, and Kokei Takata. "Komugi saibai shiken kara mita shushi e no jukinzoku no chikuseki ni tsuite." (Accumulation of heavy metals in wheat exposed to the emission particulates of a zinc refinery). Japan Society of Air Pollution, Proc. Symp. Japan. Soc. Air Pollut., 13th, Paper 179 225 (1972).

Experiments were conducted on the cumulative effects of heavy metals (cadmium, lead, and zinc) absorption on wheat through the surface of leaves. Wheat seedlings were planted in 1/5000 Wagener pots and wooden boxes. The dusts emitted from the sintering process of a zinc refinery were identified by an X-ray diffraction device, and homogeneous test material of 1% Cd, 20% Pb, and 30% Zn was prepared and was sprayed on the leaves. Plastic coverings were used to prevent the dusts from falling on the soil. With the Cd concentration between 30 and 300 ppm, the Cd accumulation in the grains was about 1.15 ppm; but when the concentration was more than 1000 ppm, the accumulation in the grains increased drastically. When 25 ppm cadmium sulfide solution was sprayed on the leaves, the amount of accumulation in the grains differed depending on the time of spraying. The crucial time seemed to be the time of the formation of the ear and the beginning of ripening. The mutual effects between Cd-Zn, Cd-Pb, and the secondary multiplication effects of Cd-Pb-An were all clear, and there was a significant difference with less than 1% danger rate. The accumulation of Cd in the grains was offset by Zn, but the presence of Pb multiplied the Cd accumulation.
Source: 1

#1559

Nakagawa, Y., H. Mitsugi, N. Takata, and H. Watanabe. "Jukinzoku-to no shokubutsu e no torikomi ni tsuite." [On the accumulation of heavy metals in plants]. Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):314 (Oct. 1973).

Accumulation of toxic metals in plants caused by air pollution was investigated in the vicinities of a steel industry and nonferrous metal industries. The tree leaves were sampled, cleansed, burned to ashes at a low temperature, dissolved in dilute nitric acid, and measured by atomic absorption spectrophotometry. The trees examined were paulonia, cherry, plane, and gingko, and the metals extracted were iron, manganese, zinc, cadmium, and lead. All heavy metals were accumulated in leaves approximately in direct proportion to the amount of metals in the air. The Fe concentration in leaves decreased in proportion to the distance from the emission source, but Mn tends to increase with the distance. The relationship between these accumulations and Fe and Mn in the soil was not clear. All Cd, Pb, and Zn concentrations in leaves decreased in proportion to the distance from the emission sources. Cadmium in soil showed the same tendency as leaves, but Pb and Zn content in the soil fluctuated.
Source: 1

#622
Nakajima, Y., S. Hagiwara, and S. Ogawa. "Jumoku to jinai ni kansuru shiken." (Experimentation of relation between trees and dust). Text in Japanese. Ringyo Shikensho Jiho (Bull. Fukoka-ken Forest Exp. Station), 22:31-35 (March 1972).

In order to clarify the effect of dust on trees, 11 kinds of infant trees were planted in April 1969 on a seedplot in the Forest Experiment Station. Fly ash (pH 6.5) and cement dust (ph 11.6) were used. Every 10 days, 1/3 of 20 g/sq m/mo and 70 g/sq m/mo were sprayed on the plants. The period for spraying was 17 mo from July 1969 to Dec. 1970. In order to see the effect of treatment with dust on growth of trees, the growth index was determined. Also, changes in soil pH caused by treatment with dust were measured. However, the result of this experiment revealed symptoms of damage caused by the treatment with dust. One of the reasons was that this experiment was conducted under conditions fairly different from actual atmospheric conditions polluted, in which the dust is constantly affecting the trees. Also, the dust causing change in soil, was pointed out. Source: 1

#624
Nakamura, Akira, Shinichi Chiyo, and Makoto Yao. "Hokkaido Tomakomai chiku ni okeru io sankabutsu osen ni tsuite (daiippo)." (On sulfur oxides air pollution in Tomakomai, Kokkaido). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):494 (Oct. 1973).

The Tomakomai industrial site at present emits about 6600 N cu m/hr of sulfur oxides from its paper industries and thermal power plants. Further development of petroleum refining, petroleum chemical, and electric power plants in the eastern development site will increase the emissions. In order to control further damages of valuable, rare plants in the eastern area, the sulfur content in plant leaves were measured. Samples of oak, Japanese oak, white birch, sage brush and some others were taken in July, August, and early September; they were washed, dried, and crushed, and the total sulfur and soluble sulfur in particles smaller than 40 mesh were quantitated by the barium chloride weight method. The patterns of SO x concentration in the air and soluble sulfur in leaves had a definite relationship, though the soil sulfur content and the weather must be taken into consideration before using those plants as air pollution indicators. At present, sage brush sampled in East Tomakomai has 0.05-0.08% of soluble sulfur but in Tomakomai and North Tomakomai, the content ranges 0.25- 0.5%. In these areas, visible damages of azalea are noted and in one area, the plant growth is impaired by fluorides. The intake of soluble sulfur in plants is lower in these areas in proportion to the SO x concentration in the air. Source: 1

#623
Nakamura, H., and S. Matsunaka. "Taiki osen kanshi-yo shihyo shokubutsu ni kansuru kenkyu(I), Kokaguka okishidanto ni taisuru asago no shihyosei." (Studies on indicator plants for monitoring of air pollution (I). Morning glory as a photochemical oxidant indicator). Text in Japanese. (Presented at the Japan Society of Air Pollution, Annual Meeting, 14th, Fukushima, Japan, Paper 57, Nov. 6-8 1973.) Taiki Osen Kenkyu(J. Japan. Soc. Air Pollution), 8(3):307 (Oct. 1973).

In 1972, 20 species of morning glories were used as photochemical oxidant indicators in a natural light gloss cabinet with an exposure device. The same species were planted again in May 1973, and they were exposed to natural photochemical oxidants in July and August when the level of oxidants rose to 0.13 ppm,0.18 ppm on five occasions. For the 1972 exposure tests, the species Heavenly Blue showed the greatest susceptibility, and the rest less sensitive; Purple Lion showed an especially, strong resistance. The five natural oxidant exposures showed a similar result. Heavenly Blue and Scarlet O'Hara showed the greatest susceptibility and others showed less. Small species were generally less sensitive. Purple Lion was extremely healthy and showed no damage. The damages appeared first in white spots, which developed into necrosis.
Source: 1

#1619
Nakamura, Katsuya. "Toshi kankyo no seibutsu shihyo to shiteno Tokyo-to no mokusei no kaika gensho." (The blooming condition of fragrant olives in Tokyo metropolis as an index for urban environment). In: Study on Animals and Plants as Human Environmental Indices Under Urban Environment, Japan Environmental Agency, p. 81-88 (March 1973).

The degree of blooming of fragrant olives in Tokyo was investigated by a questionnaire sent out to schools, parks, temples, and shrines in 23 districts of metropolitan Tokyo. Responses were obtained from 299 schools, 17 parks, and 59 temples and shrines. The species, the general condition of blooming, the general condition of the tree such as length of branches and density of leaves, the size, descriptions of the environment, and maintenance conditions were questioned. As control areas, three locations in Tama county in western Tokyo were chosen. In metropolitan Tokyo, percentages of totally nonblooming trees by species were 25.5% for yellow flowers, 25% for white flowers, and 100% for cream colored flowers. In the Tama areas, only 1.7% of the yellow type did not bloom at all. The resistance of yellow fragrant olives to sulfur dioxide is considered rather strong according to past contact experiments; however, the effect of SO2 on the blooming condition is not known. Blooming of fragrant olives is very much affected by air pollution, lack of water, or deterioration of the soil, though it is not known which of these factors controls the flowering condition. It is known that SO2 deteriorates photosynthesis and decreases carbohydrates in trees. The reason for the fragrant olives in Osaka area not blooming may be due to the deterioration of the tree metabolism of carbohydrate. Geographically, the distribution patterns of nonblooming trees coincides in the areas in Tokyo with more than 0.04 ppm SO2. However, the degree of blooming has imprived considerably since 1972; whether this is due to the decrease of SO2 concentration in the atmosphere will require further investigation.
Source: 1

#1620
Nakamura, Katsuya. "Toshi kankyo to niwaki no susubyo no hassei ni tsuite." (Urban environment and proliferation of tree perisporia). In: Study on Animals and Plants as Human Environmental Indices under Urban Environment, Japan Environmental Agency, pp. 89-100 (March, 1973).

The tree disease that looks like black sooty mold is tree perisporia and is prevalent in the Tokyo area. This fungus is nourished by the sweet secretion of concha vermin and is spread by ants, houseflies, and wasps. Therefore there is a close correlation among concha vermin, ants, and perisporia fungi infestations. The prevalence of the disease and the types of concha vermins were investigated on serveral evergreen species in the 23 districts of metropolitan Tokyo and three unpolluted areas of western Tokyo. Parts of branches and leaves of diseased trees were put into polyvinyl bags, concha vermins on the back of the leaves were taken off, and the leaves were washed carefully. The water was filtered through filter paper which had been dried and weighed before the experiment. The filter paper was again dried and weighed to see the weight of the fungi. The fungi weight varied from 0.3 mg to 2.1 mg sq cm. The amount of soot on undiseased leaves was 0.06 mg. It was discovered that in the metropolitan Tokyo area where the atmosphere is polluted, two species of concha vermin were the prevalent source for perisporia proliferation. In the three Tama areas west of Tokyo, another type of concha vermin was the nutritious source. Air pollution controls the natural enemies of concha vermin and promotes infestation of specific types of concha vermin. Therefore, certain types of perisporia, nourished by specific concha vermins can be used as an index for air pollution.
Source: 1

#626
Nakashima, Y., Y. Hagihara, and S. Ogawa. "Jumoku no engai ni kansuru Kenkyu (Dainiho) - SO_2 ni yoru kyusei higai shojo ni tsuite." (Studies on the smoke damage of tree (2). On the acute damage symptoms by the SO_2). Text in Japanese. Fukoka-ken Ringyo Shikenjo Jiho (Bull. Fukuoka-ken Forest Exp. Station), 22:1-28 (March 1972).

Acute sulfur dioxide symptoms in staple tree-planting species were examined. Experiment results on three species: Cryptomeria japonica, Pinus thunbergii, and Liquidamber styraciffua, concerning the effects of fertilizer on damage symptoms are also presented. Practical SO_2 resistance power against chronic damage can be recognized from the results of acute damage. The appearance of SO_2 acute damage was slow in plants using NPK manure and compost, and the damage was slight. In control plots, the damage appeared soon, with much leaf burn and leaf foil; the rate of semi-dead or dead trees was high. For the purpose of tree planting in air pollution regions, fertilization is indispensable as one means of searing healthy trees.
Source: 1

#625
Nakashima, Y., Y. Hagihara, and S. Ogawa. "Jumoku to jinai ni kansuru shiken." (Notes on the dust damage of tree). Text in Japanese. Fukoka-ken Ringyo Shikenjo Jiho (Bull. Fukoka-Ken Forest Expt. Station), 22:31-35 (March 1972).

Sulfur dioxide, chlorine,and fluorine affect trees. Eleven kinds of young trees were planted in April 1969. The fly ash and cement dust were spread three times/ month through 17 months on the trees of the test groups which were compared with the trees of control groups. There was no visible negative effect of the ash and the dust on the development of trees. The developmental index for each kind of the tree was measured and is shown on a graph. The pH of the soil of each group was measured and is shown on a table.
Source: 1

#1621
Nash, T. H., III. "Lichen sensitivity to hydrogen fluoride." Bull. Torrey Botan. Club, 98(2):103-106 (March-April 1971).

Lichens were exposed to hydrogen fluoride in fumigation chambers and by transplant to areas near industrial fluoride emissions to assess the sensitivity of the plants to the gas. Lichens exposed to ambient fluoride at 4 micrograms/cu m accumulated fluoride within their thalli; and, whenever, the level of fluoride within the thallus exceeded 80 ppm, chlorosis was observed with subsequent degradation of pigments and disintegration of the thalli. The finding of chlorotic transplants in the field correlated with high levels of fluoride detected on lime filter papers, suggesting that ambient fluoride was the cause of lichen injury. The lichen's ability to accumulate fluoride appeared to be a function of relative humidity which determines the moisture conditions of the thallus.
Source: 1

#1622
Nash, T. H., III "Simplification of the Blue Mountain lichen communities near a zinc factory." Bryologist, 75(3):315-324 (1972).

The effect of zinc factory emissions on lichen communities was investigated. In Lehigh Water Gap near a zinc factory, species diversities of corticolous, saxicolous, lignicolous, and terricolous lichen communities were markedly reduced as compared to the specied diversities of lichen communities in Delaware Water Gap. Nine lichen species were found in Lehigh Water Gap; 84 were found in Delaware Water Gap. Foliose, fruticose, and crustose species, respectively were increasingly more tolerant of the conditions around the zinc factory. The effect of factory emissions on the lichen flora was discernible up to 6 km to the west and 15 km to the east of Lehigh Water Gap.
Source: 1

#842

Nash, T.H., III. "The effect of air pollution on other plants, particularly vascular plants." In: Air Pollution and Lichens, B.W. Ferry, M.S. Baddeley, and D.L. Hawksworth (eds.), Toronto Univ. Press, Toronto, 192-223 (Chapt. 10) (1973).

The effect of air pollution on vascular plants, mosses, and fungi is reviewed. Specific pollutants include sulfur dioxide, fluorides, ozone, nitrogen oxide, peroxyacetyl nitrate (PAN), and particulates. A mean annual local concentration of SO2 above 0.01-0.08 ppm causes extensive phytotoxic effects in many species. Symptoms of fluoride poisoning vary tremendously between plant groups. Background variations of F2 in plants generally range between 0.5 and 25.0 ppm by weight. The range of 25-105 ppm is the critical range for sensitive species. The most sensitive species are injured by O3 fumigations between 5 and 12 pphm for 2-4 hr, while resistant species tolerate concentrations as high as 100 pphm. Plants respond physiologically to subacute dosages of NOx although higher concentration of NOx than SO2 are required to produce necrotic markings. Damage from PAN can occur at concentrations below 0.1 ppm. The chloroplasts are particularly sensitive. Damage can also occur from ethylene, chlorine, hydrogen chloride, ammonia, and heavy metal particulates as arsenic, copper, lead, zinc, cadmium, iron, nickel, and cobalt. Mosses are approximately as sensitive to air pollution as lichens and are affected by SO2, O3, F2, and some heavy metals. Fungi are also sensitive to SO2 and O3.
Source: 1

#1623

Nast, T. A., and A. G. Hassouna "Tolerance of bananas to fluorides and sulphur dioxide." Alex J. Agr. Res., 18(1):115-118 (1970).

The sensitivity of banana plants growing near the superphosphate plant at Kafr-El-Zayat, U.A.R. to fluorides and sulfur dioxide was investigated. The growth of the fourth ratoon plant raised in this area was compared with that of plants raised in a non-industrial area (Alexandria). The results indicated that the plants from the two areas were similar in terms of height of the pseudostem, length of the bunches, average number of hands per bunch, number of fingers per hand, and average number of fingers per hand per bunch. The plants in Kafr-El-Zayat showed no visual symptoms of foliage lesions, severe chlorosis, or necrosis. Although the margins of the lamina were dry and scorched, the same observations were made of the plants in Alexandria. The air pollutants in the area at Kafr-El-Zayat are present in concentrations not injurious to banana plants grown in the area.
Source: 1

#627
National Environmental Research Center, Research Triangle Park, N. C., Office of Research and Development. "Effects of sulfur oxides in the atmosphere on vegetation: revised chapter 5 for air quality criteria for sulfur oxides." ROAP No. 26AAA, Task 16, Program Element 1A1001, EPA-R3-73-030, 56 p. (Sept. 1973). NTIS:PB-226314/AS.

Limitation in the criteria for secondary standards in the publication Air Quality Criteria for Sulfur Oxides are discussed. Chapters 5 and 10, relating to the effects of sulfur oxides on vegetation are revised. Effects of SO_x in the atmosphere on vegetation are summarized, based on a literature review of 700 articles. For plants, such as maple trees, spinach, and sweet potatoes that are sensitive to sulfur dioxide, damage or reduction in growth or yield may result from short-term exposures as low as 131 to 1316 micrograms/cu m (0.05 to 0.5 ppm) over an 8 hour period or 2620 to 10,480 micrograms/cu m (1.0 to 4.0 ppm) over period of 30 min. More resistent plants such as oak trees and corn may require exposures of over 5240 micrograms/cu m (2 ppm) for the 8-hour period or over 26,000 micrograms/cu m (10 ppm) for the 30-minute period. Growing season average concentrations as low as 26 tl 66 micrograms/cu m (0.010 to 0.025 ppm) have been reported to affect a large number of agronomic species. These averages were associated with maximum 30-minute values of 2096 to 4978 micrograms/cu m (0.8 to 1.0 ppm). Foliar and growth affects of mixtures of SO_2 with other pollutants, may be greater than the effects of SO_2 alone, and nitrogen dioxide produces greater effects than either pollutant alone.
Source: 1

#1624
National Research Council, Ottawa (Canada), Associate Committee on Scientific Criteria for Environment Quality. "Lead in the Canadian environment (final report)." Pub.BY73-7(ES), 117 p., December 1973.

Background information is presented for the geochemistry, use, release, and biological effects of lead in the Canadian environment. Topics covered include: historical information; industrial and nonindustrial sources of lead release; current lead levels in the Canadian environment; lead in vegetation; the toxicity of lead to aquatic life; lead in domestic and laboratory animals; human lead intake from all sources; and epidemiology, toxicology, and diagnosis of human lead intoxication . Analytical methods and lead criteria are provided in an appendix.
Source: 1

#1625
Navara, J. "Prispevok k ucinku fluoru na knicenie semien vo vztahu k prirodzenemu obsahu populovin a niektorych biogennych prvkov." (A contribution concerning effect of fluorine on seed germination in relation to the natural content of ash and some biogenic ends). Translated from Russian, Belov and Associates, Denver, Colo., 11 p., Jan. 2, 1971. Biologia, 19(8):589-596 (1964).

The effects of low and high concentrations of fluorine on the germination of seeds of peas, barley, white mustard, kohlrabi, and carrots were studied in relationship to the mineral content of the seeds. Fluorine was applied by soaking seeds for 20 hrs. in various concentrations of sodium fluoride. High concentrations of fluorine inhibited germination of pea and barley seeds and, to a lesser extent, mustard and kohlrabi seeds. Seeds of poppies and carrots were relatively unaffected. For the most part low concentrations of fluorine had a stimulating effect that was apparent in speed of germination and overall ability to germinate, as well as root growth and the growth of coleoptiles. Increasing the calcim content of seeds by the application of $Ca(NO3)2$ decreased the inhibiting effects of fluorine on the geermination process. The levels of other mineral elements in seeds appeared to have no correlation with tolerance to fluorine.
Source: 1

#843

Navara, J. "Beitrag sur Kenntnis der Wasserhaushalt der Pflanzen bei Anwesenheit des Fluors im Substrat." (Some data on the water balance in plants in the presence of fluor in the substrate). Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, 91-97 (1968).

Studies were conducted of the water balance of the Senator variety of Pisum sativum in the presence of fluor (in the form of sodium fluoride) in the substrate. The effect of fluor was seen in a withering of those portions of the plant above the soil. The unfavorable hydration condition observed is the result of changes in the amount of water assimilated and the amount given off. The presence of fluor first stimulated and then reduced the amount of water given off. No preliminary increase was noted before the amount of water taken in was reduced, and plants assimilated no water after 68 hrs in the presence of 0.29 and 0.25 g/l F. A balance between the amount of water taken in and given off was reached only after approximately 27 hrs at a level of approximately 40% of the original transpiration and approximately 90% of the original water content of the plant.
Source: 1

#1626

Navara, Jan. "Zmeny v intenzite transpiracie a poskodenie rastlin pri psosbeni fluoru z ovzdusia." (Variations in the intensity of transpiration and damage to plants caused by fluorine present in the atmosphere). Biologia (Bratislava), 27(7):545-559 (1972).

The effect of various atmospheric fluorine concentrations on transpiration intensity and the health of leaves of 10-day-old plants of Pisum sativum was studied under conditions of continuous and periodic fumigation. Transpiration intensity was determined gravimetrically by a special appartus. Low fluorine concentrations (50 ppb), following a temporary drop in water transpiration, resulted in a marked increase in transpiration. Following the attainment of maximal increase, transpiration decreased again to end up shortly before the appearance of visible leaf damage at lower intensity than control plants unexposed to fluorine. Higher concentrations (100-150 ppb) led immediately to a gradual drop of transpiration intensity which continued throughout the stage of invisible and visible leaf damage. Lower and higher fluorine concentrations also affected the appearance of leaf damage. Leaf necrosis appeared sooner at higher, later at lower, fluorine concentrations. At lower concentrations, upper ontogenically younger leaves turned light brown which was followed by peripheral necrosis on fully developed leaves. Concentrations of 150 ppb caused a different type of damage: after one day of fumigation, the leaves began to wilt. Transpiration intensity at high fluorine concentrations dropped more markedly in plants growing at relatively lower humidity, at higher relative humidities the effect of fluorine was less noticeable. Periodic fumigations disclosed that at night plants were more sensitive to the effect of fluorine than during the day: transpiration intensity dropped more.
Source: 1

#628

Neger, F.W. "Ein neues, untruegliches Merkmal fuer Rauchschaeden bei Laubhoelzern." (A new unfailing criterion for flue-gas damage on deciduous trees). Agnew. Botan., 1:129-138 (1919).

Lenticle damage in trees exposed to sulfur dioxide is considered as a criterion for flue gas damage on deciduous trees. Concentrations ranging from 0.001, to 0.00005 SO2 were applied in laboratory conditions where ash tree, lime, and Norway maple branches appeared to be the most sensitive species. Damage was most severe in lenticels near the intensely respiring sprout buds. Ash tree lenticel damage occurred when exposed to SO2 concentrations between 0.0001 and 0.00005. Oak, beech, apple, and birch trees appeared to be less sensitive. Field tests carried out in sulfur dioxide polluted areas confirmed the laboratory findings. Lenticel damage and browning of the surrounding portions elicited microscopically the same pattern as the damage induced under laboratory conditions. Adverse weather conditions such as frost or heat which may induce deadly damage to sprouts appear to produce different effects than the specified lenticel damage.
Source: 1

#967
Nelson, D. W., and J. M. Bremner. "Gaseous products of nitrite decomposition in soils." Soil Biol. Biochem., 2:203-215 (1970).

Studies of gaseous products formed by chemical decomposition of nitrite in soils showed that substantial amounts of N_2 and NO_2 and small amounts of N_2O were evolved on treatment of neutral and acidic soils with nitrite, the largest amount of N_2 being formed in an acidic soil having a high organic matter content. The amount of NO_2 produced was inversely related to soil pH, but significant amounts of NO_2 were evolved from soils having pH values above 7. The failure of some investigators to detect NO_2 as a product of nitrite decomposition in acidic soils can be attributed to use of closed experimental systems that promoted sorption of this gas by moist soils and conversion of NO_2 to nitrate. A study of the self-decomposition reaction of nitrous acid showed that this reaction does not proceed according to the classical equation $3HNO_3+2NO+H_2O$ and is better represented by the equation $2HNO_2= NO+NO_2+H_2O$. Evidence was obtained that organic soil constituents are responsible for the reduction of nitrite to N_2 and N_2O and for the fixation of nitrite N observed on treatment of soils with nitrite and that inorganic soil constituents are not involved in these reactions. Several experiments indicated that most of the NO_2 evolved on treatment of soils with nitrite is formed by self-decomposition of nitrous acid and by atmospheric oxidation of NO produced by this reaction.
Source: 5

#288
Neuberger, H. "Condensation nuclei - their significance in atmospheric pollution." (Presented at a Joint Fuels Conference of the American Inst. of Mining and Metallurgical Engineers and The American Society of Mechanical Engineers, Cincinnati, Ohio, Oct. 20-22, 1947.) Mech. Eng., 70:221-225 (March 1948).

Author discusses the constituents of the atmosphere and refers to the suspensions in the atmosphere as "aerosols." Explanations of dust and condensation nuclei including their chemical and physical nature are included. Also included is a section on the sources of nuclei as well as biological effects of aerosols. Charts include: Sulphur content of air and average number of nuclei in representative cities: Average ultraviolet radiation and number of condensation nuclei for clear skies; Average number of condensation nuclei per cubic millimeter for clear and cloudy skies; Mean number of condensation nuclei for various ranges of dust concentration in city air; and Retention of condensation nuclei in human respiratory system for various concentrations of nuclei in air.
Source: 1

#63
Neuberger, H., C.L. Hosler and W.C. Koemond. "Vegetation as aerosol filter." Biometeorology, 2(2):693-702 (1967).

Measurements of ragweed-pollen concentrations inside and outside a forested area during two seasons revealed that 100 m inside a dense coniferous forest more than 80 percent of the pollen is removed from the air; deciduous trees seem somewhat less effective in this respect. Laboratory determinations of the filtering effect of coniferous and deciduous plant material on Aitken nuclei showed the coniferous material to remove on the average 34 percent (477 measurements), deciduous material 19 percent (348 measurements) of the submicroscopic particulate matter from the air.
Source: 8

#629
Neustein,S.A., and N.P. Danby. "Potential atmospheric pollution from the Invergordon industrial complex." Sci. Forest, 24: 270-273 (Nov. 1971).

The main atmospheric pollutants from the Invergordon complex will be fluorine and hydrogen fluoride from the aluminum smelter and sulfur dioxide and hydrocarbons from the oil refinery. Both acute and chronic tree damage is expected. The effects of F and SO_2 on the trees via the soil is expected to be insignificant. Acute tree damage results from high concentrations of pollutants as a result of meteorological conditions or industrial cleansing failure. Chronic tree damage results from long term low level pollution. Broad leaved trees are not regarded as susceptible to chronic pollution. All the conifers are susceptible. Clean air sampling has begun in order to provide before and after comparison. Foliage samples will be taken for a radius of 16,000 M. A survey of lichens has been completed. Lichenolgy may assist in discrimination between F and SO_2 injuries.
Source: 1

#1219
Neuwirth, R. "Der Wald als Aerosolfilter." (The forest as an aerosol filter). Wetter und Leben, 8:133-147 (1956).

An aerosol is a suspension of fine solid or liquid particles in gas. The methods used to determine the size and the amount of the particles are described. It is pointed out that research in this field has just begun. However, it can be said that forests have the capability to filter aerosols in all concentrations. It was found that the degree of the filtration depends largely on wind intensity. During periods of low wind intensity, the count of particles in the center of forests was very high; during periods of high wind intensity, a significant difference was observed in the count of particles in the center of forests and in the surrounding areas.
Source: 6

#1256
Nicolet, M. "La biosphere au service de l atmosphere." [The biosphere in the service of the atmosphere]. Bull. Cl. Sci. Acad. Roy. (Belgium), 58(5): 1431-1437 (1972).

Interactions occurring between natural and anthropogenic emissions from the biosphere and atmospheric gas constituents are described. Ultraviolet radiation at wavelengths below 3200 A produces excited oxygen atoms, a small fraction of which react with water vapor, methane, and hydrogen, yielding free hydroxyl groups which again react with methane and hydrogen. The destruction of CH_4 leads to the formation of carbon monoxide which, reacting again with hydroxyl groups, yields carbon dioxide. Nitrous oxide emitted by soil bacteria reacts with excited oxygen atoms in the atmosphere to yield nitric oxide. Photochemical equilibrium between atmospheric NO and nitrogen dioxide was evidenced. The OH radical resulting from the decomposition of water vapor reacts with NO_2 to yield nitric acid which is then washed out by precipitation.
Source: 1

#1627

Nieboer, E., H.M. Ahmed, K.J. Puckett, and D.H.S. Richardson. "Heavy metal content of lichens in relation to distance from a nickel smelter in Sudbury, Ontario." Lichenologist, 5:292-304 (1972).

The Sudbury region of Ontario has large deposits of nickel, iron, and copper, and thus a number of smelting plants which produce sulfur dioxide and heavy metal pollution. Since lichens are good indicators of SO2 pollution levels, the pattern of heavy metal content in lichen species in the area of a copper smelter in Sudbury was correlated with distance from the smelter to ascertain whether lichens might also be good indicators of the amount of heavy metal fallout. The lichens were analyzed qualitatively and quantitatively. All seven species of lichens contained copper, zinc, iron, nickel, manganese, and lead. Cadmium and cobalt were detected in two species. Neither gold nor silver could be identified in lichen material with the tests used. A pollution model was developed and compared to field results. The simple dilution of the stack effluent was consistent with the fact that the lichen metal content was related to the reciprocal of the distance from the pollution source. The lichens from the area could tolerate simultaneously high concentrations of several heavy metals that are known to be toxic to other plants. The mechanism of metal uptake was not clearly established. The study showed that lichens and other epiphytes are potentially the most useful indicators of heavy metal fallout around industrial plants.
Source: 1

#1632

Nikolaevskiy. "Indicators of gas resistance of arboreal plants(according to investigations conducted in the city of Krasnoural'sk). In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature, Vol 3., Silver Spring, Md., American Inst. of Crop Ecology, 1970, p. 70-94. Also: Tr. Inst. Bid. Ural. Filial Akad, Nauk USSR, 31:59-79 (1963).

Two hundred trees in an industrial city heavily contaminated with sulfur dioxide and fluorine compounds were studied for their degree of gas resistance. The trees included aspen, balsam poplar, box elder, crab apple, and white birch. The studies were made in the summer and covered the following physiological processes: photosynthesis, respiration, transpiration, activity of the stomas, quantity of easily oxidizable substances, water holding capacity of the leaves, cell pH content, concentration of the dry matter in leaves, and anatomical features of leaf structure. Intensity of the basic physiological processes was, to a significant extent, connected with the functioning of the stoma apparatus, reduction of the stoma apertures decreasing the rate of gas exchange. The gas-resistant box elder was characterized by smaller stoma apertures and by low intensity of photosynthesis and respiration during the growing period. In contrast, intensity was high in the greatly susceptible birch and crab apple. Although the highest transpiration intensity was found in the box elder, transpiration does not appear to be a reliable index of gas resistance.Total leaf water content correlated well with susceptibility to gas damage. Gas resistant species were also characterized by a smaller amplitude of fluctuations of the amount of ozidizable matter and by smaller amounts of this matter, by lower concentrations of dry matter and by less decrease in cell pH content.
Source: 1

Data are presented on changes in catalase, polyphenol oxidase, and peroxidase activity in leaves of ash leaved maples and European white birch exposed to small and high concentrations of sulfur dioxide. The difference in enzyme activity in the two species confirm the assumption that the intensity of photodynamic oxidation under the influence of sulfur dioxide and light is proportional to the oxidation reduction activity of enzyme systems in plants. Maples are characterized by a lower intensity of gas exchange and enzyme activity, and consequently by a lower vulnerability. Catalase activity clearly decreased under the influence of even small sulfur dioxide concentrations. The decrease is likely to contribute to an increase in oxidation processes and to plant damage.
Source: 1

#844

Nikolaevskiy, V.S. "The Gas Resistance of Local and Introduced Arboreal Plants Under The Conditions Existing in Sverdlovsk Oblast." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects and Symptoms of Air Pollutes on Vegetation: Resistance and Susceptibility of Different Plant Species in Various Habitats, in Relation to Plant Utilization for Shelter Belts, and as Biological Indicators. M. Y. Nuttonson, (ed.), Vol. 2,Silver Spring, Md., American Institute of Crop Ecology, p. 44-49, 1969. (Also: Tr. Inst. Ekologii Rasteniy Zhivotnykh, Akad. Nauk SSSR Ural. Filiai. (Sverdlovsk), 54:85-89 (1967)).

In the planting of trees around industrial centers and cities in the Central Urals with a significant amount of acid gas pollution, a wider use is made of introduced species, as compared with the use of local species. This is because the introduced species are more ornamental and also more gas resistant. The relatively high gas resistance of a number of introduced species is explained by their higher plasticity and adaptability to new ecological conditions. Six groups were isolated on the basis of gas resistance by a study of the physiological-biochemical characteristics of trees and the anatomicalmorphological structure of their leaves. The recommended gas-resistant species are box elder, red-berried elder, spindle tree, snowberry, silverberry, oleaster, elm, pubescent lilac, and Canadian poplar. From the native species, only Tartar honeysuckle and sallow willow can be used.
Source: 1

#631

Nikolayevskiy, V. S. "Physiological-Biochemical Principles of the Gas Resistance of Plants." In: American Institute of Crop Ecology Survey of USSR Pollution Literature. Gas Resistance of Plants with Special Reference to Plant Biochemistry and to the Effects of Mineral Nutrition. M. Y. Nuttonson (ed.), Vol. 9, Silver Spring, Md., American Institute of Crop Ecology, p. 1-27 (1971). Translated from Russian. (Also: Uch. Zap., 222:5-33 (1969).

#1631

Nikolayevskiy, V.S. "The Effect of Sulfur Dioxide on Woody Plants Under the Environmental Conditions Prevailing in the Sverdlovsky Region." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Vol. III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union. M. Y. Nuttonson (ed.), Silver Spring, Md., American Institute of Crop Ecology, p. 58-67 (1970). Translated from Russian. (Also: Okhrana Prirody na Urale, 4: 123-132 (1964).

A study of gas resistance of woody plants investigating photosynthesis and respiration, water conditions, pH, Eh, and rH2 of cell sap, the movement of stomata, and the quantity of readily oxidizable substances is reported. Also studied were the anatomical properties of leaves and the dynamics of their susceptibility to injury in woody plants growing under conditions of the copper smelting industry of the Central Urals (Krasnoural'sk, Kirovgrad, and Revda), as well as in a laboratory were used. The physiological indices were studied for five species; balsam poplar, dwarf apple, European white birch, aspen, and box elder. The investigation was carried out under conditions of intermittent gassing (200 m from smelter) and under conditions free of gases (trees in a forest glade of about 500 m diameter and at a distance of 7 km from the smelter). In the forest glade study the naturally growing aspen and European white birch were utilized. In addition there were planted balsam poplar, dwarf apple, and European white birch. Under the influence of acid gases, and particularly under simultaneously acting urban conditions the five investigated species: box elder, balsam poplar, aspen, European white birch, and dwarf apple, showed a distinct reduction in the openings of their stomata in autumn, the extent of this reduction differed for the different species. In the absence of gassing, the reverse was true. The smallest opening of the stomata during the vegetative period was observed in the box elder. This could be the reason for the decrease in the rate of gas exchange, which is conducive to a reduction in the vulnerability of the leaves to noxious gases. High concentration of sulfur dioxide causes considerable narrowing of the stomata of the leaves of woody species and upsets the normal course of physiological processes. Thus, the intensity of photosynthesis drops and respiration is observed in daylight. In addition, acidification of cell sap and a decrease in the quantity of oxidizable matter is also observed. The greater damages, which manifest themselves in appreciable acidification of cell protoplasm, and in an extensive disturbance of photosynthesis, are observed in the less resistant species, dwarf apple and birch. These disturbances appear to a lesser extent in the more resistant species, poplar and lilac.
Source: 1

#845

Nikolayevskiy, V. S. "Effect of Sulfur Dioxide on the Enzymatic Activity of Tree Leaves." In: American Institute of Crop Ecology. Survey of USSR Air Pollutant Literature. Vol. III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environment Conditions in a Number of Industrial Regions of the Soviet Union. M. Y. Nuttonson (ed.), Silver Spring, Md., American Institute of Crop Ecology, p. 109-114, 1970. Translated from Russian. (Also: Okhrana Prirody na Urale, 5:19-23 (1966).

Principal advances in research pertaining to the gas resistance of plants are reviewed. The influence of toxic compounds on the anatomical-morphological structure of leaves and the physiological-biochemical characteristics of plants is considered. Also, the species of plants resistant to various compounds in different physico-geographical zones have been ascertained. Investigators have undertaken detailed studies of the chemistry of injuries to plants by acid gases, as well as the chemical mechanism of transformation of sulfur dioxide in plants and its influence on the metabolism of carbon compounds, with the aid of isotopic techniques. Considerable attention has been given to the development of methods for studying gas resistance of plants. Of major importance for a successful diagnosis and study of the gas resistance of plants is the establishment of direct indicators characterizing the degree of plant resistance. The effects of ammonia, mercury, acids, fluorine, chlorine, and other pollutants on plants are described.
Source: 1

#1630
Nikolaevskiy, V.S. "The activity of certain enzymes and gas resistance of woody plants." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Vol. III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown under Diverse Environmental Conditions of the Soviet Union, M.Y. Nuttonson (ed.), Silver Spring, Md., American Institute of Crop Ecology, p.95-99 (1970).

Peroxidase, polyphenoloxidase, and catalase activity was studied in leaves of the box elder (resistant to sulfur dioxide) and European birch (non resistant). Also investigated was the effect of different concentrations of SO2 on the susceptibility of the plants to injury in relation to enzyme activity. Catalase activity was low and peroxidase activity high in leaves of box elder in summer, while the reverse was true for the birch. The birch began to exhibit polyphenoloxidase activity in the fall; the elder displayed the phenomenon later. Enzyme activity in the elder and birch varied according to susceptibility to SO2. Weak concentrations slightly decreased catalase activity in the elder and increased peroxidase activity. The same concerntrations significantly decreased catalase activity in the birch but did not affect peroxidase activity. The results suggest that inhibition of catalase can activate peroxidase, which apparently enables plants to resist poisoning by peroxides.
Source: 1

#385

Nikolayevskiy, V.S. "Nekotoryye zakonomernosti poglosheniya sernistogo gaza drevesnym rasteniyami." (Some regularities in absorption of sulfur dioxide by wood plants). Gorkiy (A.M.) State Univ. (USSR), Perm Order of the Red Banner of Labor, Uch. Zap. perm. Ordena Trydovogo Krasnogo Znamenii Gos. Univ. im. A.M. Gorkogo, 277(5):29-35 (1971).

The rate of absorption of sulfur dioxide by trees, flowers, lawn grasses, and weeds is directly proportional to the suceptibility of the leaves to injury. The rate of absorption of SO_2 in nonresistant species is two-five times and more than that of resistant ones. A statistically inverse correlation connection has been established in woody plants between the number of stoma per sq mm and susceptibility to injury by SO_2. By means of the infiltration method, the daily dynamics of movement of stoma in five species of woody plants were determined. The dependence of susceptibility to damage of plants on the daily dynamics of movement of the stoma was determined, and the reaction of the stomatal apparatus to the effect of sublethal concentrations of SO_2 was studied. The degree of the stoma opening was determined by the infiltration method three times a day on 42 species of woody plants. The effect of SO_2 on the stomal apparatus was determined by the infiltration method after exposure on the morning of the test. The susceptibility to damage of woody plants by SO_2 was related to the time of day and the amount of sunlight. The species susceptibility to damage was almost unchanged with time of day. Previous conclusions on the role of number of stoma per sq mm and their extent of opening in gas exchange rate and gas resistance were confirmed. The reactions of the stoma to the action of the gas showed that the resistant species have greater ecological plasticity, which allows them to decrease the rate of gas absorption.
Source: 1

#630

Nikolayevskiy, V.S., and V.V. Firger. "Anatomomor-fologicheskays u biologicheskaya kharakteristika dekorativyykh rasteniy v svyzsi s ikh gazoustoychivost yu." (Characteristics of ornamental plants in relation to their gas tolerance). Translated from Russian. Uch. Zap., Perm. Gos. Univ., 206:135-147 (1970).

The anatomical-morphological and biological characteristics of ornamental plants were investigated in relation to their tolerance to sulfur dioxide gas. A close reliable correlation was established between the damageability of leaves by SO_2 and the number of stomata/1 sq mm, size of the stomata,and thickness of the upper epidermis of the leaf. Gas tolerant plants are characterized by a greater number of stomata/1 sq mm, smaller stoma size, and lesser thickness of the upper epidermis. A particularly clear inverse correlation between damageability and the number of stoma is observed in plants having stomata, as in woody plants, on the lower side of the leaf. There was no reliable correlation between the gas tolerance of plants and thickness of leaf cuticle and the thickness of the epidermal membranes. Some correlation exists between the gas tolerance of plants and their winter tolerance. Light loving ornamental plants were more gas tolerant than shade tolerant and shade loving plants. There was some dependence of the gas tolerance of plants on the times and duration of flowering, as well as coloring of the generative organs.
Source: 1

#1628

Nikolayevskiy, V.S., V.V. Firger, and L.M. Belokrylova. "Svetovoy metabolizm ugleroda-14 u dekorativnykh rasteniy i ego rol v gazoustoychivosti." (Light metabolism of carbon-14 in ornamental plants and its role in gas tolerance). Translated from Russian. Uch. Zap., Perm Gos Univ., 256:55-92 (1971).

Radiochemical and radiochromatographic analyses of ornamental plants exposed to sulfur gas have confirmed the dependence of the degree of plant damage by sulfur gas on the intensity of gas exchange, and accordingly, the rate of absorption of the toxic gas and formation of lethal concentration in leaves. Differences were established in the metabolism of radiocarbon in groups of woody plants and individual species with respect to gas tolerance. The importance of alternative synthesis mechanisms in tolerant species was found to be relatively high. Sulfur gas caused an activation of photosynthesis in a tolerant species (ash-leaf maple), whereas suppression was the result in a nontolerant species (birch, barberry). Sulfur dioxide caused a slowing of the polymerization of organic compounds. Shifts in the C(14) metabolism in plants under the influence of SO_2 were associated with a variable intensification of first the carbohydrate and then the alternative synthesis mechanisms. Sulfur gas caused a nonspecific fluctuating change in the distribution of radiocarbon and an intensification of the polymerization of organic compounds in lawn plants, and some differences in the mechanisms of carbon (14) dioxide bonding were discovered in two studied species under the influence of SO_2.
Source: 1

#384

Nikolayevskiy, V.S., V.V. Firger, and G.A. Vaseva. "Metabolism of Carbon-14 Compounds in Forage Grasses and the Effect of Sulfur Dioxide on it." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Gas Resistance of Plants with Special Reference to Plant Biochemistry and to the Effects of Mineral Nutrition. M. Y. Nuttonson (ed.), Vol. 9, Silver Spring, Md., American Institute of Crop Ecology, p. 82-91, (1971). Translated from Russian. (Also: Uch. Zap., 222:57-67 (1969)).

Forage grasses differing in gas resistance to sulfur dioxide also differ in their content of oxidizable substances and ascorbic acid. Meadow fescus, a resistant species is characterized by a reduced content of oxidizable substances and ascorbic acid. Under the influence of sulfur dioxide, an increase in the content of oxidizable substances is sometimes observed. The meadow fescue is compared with timothy is characterized by a reduced intensity of photosynthesis and a lower rate of absorption of sulfur dioxide. Under the influence of sulfur dioxide, definite changes in the metabolism of carbon in forage plants are observed which are attributable to their gas resistance.
Source: 1

#632

Nikolayevskiy, V.S., and A.G. Miroshnikova. "Experience in the Use of the Biochemoluminescence Method for Diagnosing the Gas Resistance of Plants." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Gas Resistance of Plants with Special Reference to Plant Biochemistry and to the Effects of Mineral Nutrition. M.Y. Nuttonson (ed.), Vol. 9, Silver Spring, Md., American Institute of Crop Ecology, p. 50-53 (1971). Translated from Russian. (Also: Materialy Pervoy Ukrainskoy Konferentsii, Kiev, p. 115-120 (1968)).

The development of biochemiluminescence method opens up new opportunities for the study of the interpretation of the biochemical aspects of the oxidation processes in plants under the influence of sulfur dioxide. A set of electronic instruments with a high sensitivity photomultiplier were used to record spontaneous and induced oxidation processes. Etiolated plants of forage grasses were more resistant to sulfur dioxide than green plants, requiring concentrations 10 times higher than those required for green plants to produce damage. Under the influence of sulfur dioxide, the luminescence in etiolated plants increases. The activity of the luminescence is more pronounced in the resistant species, fescue, and less pronounced in timothy grass. Concentrated sulfur dioxide depresses the luminescence of both species. In etiolated plants there is no relationship between the amount of substances oxidized and the vulnerability of plants to sulfur dioxide.
Source: 1

#1629

Nikolayevskiy, V.S. and A.T. Miroshnikova. "Dopustimyye normy zagryazneniya vozdikha dlya rasteniy." (The air pollution levels permissible for plants). Gigiena i Sanit., 4:16-18 (1974).

The photosynthesis-inhibiting effect of different gaseous and particulate air pollutants in cut-off branches from 8 different tree species was studied to establish maximum allowable pollutant concentrations for plants. As a permissible pollutant concentration, that which for a period of 5 min produces no noticeable decrease in the photosynthesis of any of the 8 species with different resistances was taken. The permissible standard levels of air pollution proved to be lower for plants than for animals. The maximum allowable concentrations were 0.02 mg/cu m for sulfur dioxide; 0.05 mg/cu m for nitrogen oxides; 0.1 mg/cu m for ammonia and sulfuric acid mist; 0.02 mg/cu m for formaldehyde; 0.2 mg/cu m for methanol; 0.1 mg/cu m for benzene, 0.2 mg/cu m for cyclohexane, and 3 mg/cu m for urea and sodium sulfate.
Source: 1

#633

Nikolayevskiy, V.S. and V.V. Suslova. "Effect of sulfur dioxide on pigments of forage grass." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature, Vol 9, Gas Resistance of Plants with Special Reference to Plant Biochemistry and to the Effects of Mineral Nutrition, M.Y. Nuttonson (ed.), Silver Spring, Md., American Institute of Crop Ecology, p. 92-106 (1971).

The forage grasses meadow fescue and timothy, which differ in gas resistance to sulfur dioxide, are also markedly different during the tillering stage from the standpoint of the nature of the changes in their vulnerability in relation to gas concentration. The fescue is characterized by an almost directly proportional dependence, and the timothy, by a logarithmic dependence. During the ontogeny of the timothy, regular decrease of gas, resistance occurs, and a decrease of the sublethal and lethal sulfur dioxide concentrations results from intensification of the physiological-biochemical processes with the onset of the productive stage. During ontogeny, timothy shows a general increase in the concentration of the pigments without any appreciable change in their proportions. Under the influence of sulfur dioxide, certain differences in the destruction of individual pigment systems are observed in the plant species studied during their tillering stage. Low sulfur dioxide concentrations apparently cause an intensification of the enzymatic oxidation of the pigments, while higher sulfur dioxide concentrations, by inactivating the enzymes, cause a stabilization of the content of the pigments.
Source: 1

#34

Nikolayevskiy, V.S. and V.V. Suslova. "Gazoustoychivost i nekotoryye osobennosti pogloshcheniya S3502 gazonnymi travami." (Gas resistance and certain characteristics of absorption of S3502 by lawn grasses). Gorkiy (A.M.) State Univ. (USSR), Perm Order of the Red Banner of Labor, Uch.Zap. Perm. Ordena Trydovogo Krasnogo Znamenii Gos. Univ. im. A.M. Gorkogo, 277(5): 137-142 (1971).

The dependence of susceptibility to damage of lawn grasses on accumulation of sulfur (35) dioxide and the effect of the contaminated soils of a chemical plant on plant resistance were studied. Lawn grasses were fumigated with 0.3% by volume SO_2 for 1 hr and grown on peat or on soils from a chemical plant. Lawn grasses were the most convenient objects for the study of the patterns of gas resistance, since they permit avoidance of the subjective visual estimation method of damage evaluation. A new method of determination of susceptibility to damage to lawn grass plants was developed. It was proposed that the differences in gas resistance of individual species were determined by physiological and biochemical characteristics of the plants and that, in populations of each species, by the anatomical and morphological characteristics of the leaf structure and the amount of acid gas absorbed. The S(35) activity of all species of plants was three-25 times higher in dead leaf tissues than in living. The S(35) transport through the vessels with the water flow to the leaf tips was accomplished to a greater extent in monocotyledenous plants than in dicotyledenous ones. Toxic compounds accumulated by the soil, depending on concentration and chemical nature, can cause the death of seeds or a decrease in germination, impairment of growth and development, and changes in resistance to SO_2. An increase in gas resistance was generally observed. Lethal concentrations of SO_2 in plants of resistant species were higher than in nonresistant ones. The former are probably capable of better and more completely absorbing SO_2 in their tissues. Plants with larger leaf surface dimensions proved to more resistant to SO_2. This dependence could be connected with characteristics of the physiological and biochemical processes in species with different growth rates.
Source: 1

#634
Nikolayevskiy, V.S., V.N. Tsodikova, V.V. Firger, A.T. Miroshnikova, V.V. Suslova, and V.P. Galeyeva. "Vliyaniye anatomo-morfologicheskogo stroyeniya list er i biologicheskikh osobennostey dekorativynykh rasteniy na pogoloshcheniye S3502 i gasoustoychivost." (Anatomical-morphological and physiological-biochemical principles of plant gas stability). Translated from Russian. Uch. Zap. Perm. Gos. Univ., 256:5-53 (1971).

The effect of anatomical-morphological structure of leaves and biological features of ornamental plants on the absorption of sulfur-35 dioxide and on the stability of the gas were investigated. There was a dependence of gas tolerance on the phases of growth and development of the plants and on the rate and times of passage through phases. A greater tolerance to sulfur gas was manifested by species with a longer growing season and shortened flowering times. There was a direct, statistically reliable correlation between the damageability and intensity of gas exchange and absorption of sulfur dioxide in woody, flowering, lawn, and weedy plants. There was a close parallel similarity in the tolerance of woody plants to SO2 and chlorine, opposite to that of ammonia. The rate of gas absorption and formation of the lethal concentration of S3502 is dependent on the number of stomata and the dynamics of their movement during the daytime, thickness of cuticle, membrane of the epidermis, and the epidermis itself, thickness of the sprongy tissue, ventilability of the spongy parenchyma, and value of the h sub n/h (sub r) ratio. Xeromorphicity of leaf structure characterizes gas tolerant species, while mesomorphicity is characteristic of nontolerant species.
Source: 1

#1861
Ninova, Dafina. "Vurkhu anatomichnite pokazateli za dimoustoychivost pri nyakoi durvesni rasteniya." (Anatomical characteristics of smoke resistance in some woody plants). Gorskostop. Nauka, 12(4):9-18 (1970).

The role of the anatomical structure of leaves in smoke resistance and the effects of poison gases on those structures are described. Leaves of red oak, honey locust, white mulberry, Canadian poplar, Persian walnut, apple, and pear trees growing in the region around a copper mining combine were examined. The woody species with the greatest smoke resistance, red oak, honey locust, and mulberry, in the vicinity of the copper mining plant have the largest number of stomata per square millimeter of leaf surface, and the smallest stoma. These anatomical features occasionally are smoke resistance indicators. Comparison of the stomatic apparatuses of experimental and control variants established the fact that the number of stomata in the experimental variants of the smoke resistant species is greatly increased, an indication of the strengthening of the xeromorphic characteristics of plants when subjected to the effects of sulfur gas, as well as an indication of the considerable ecological pliancy of different smoke resistant species, and of the weaker ecological pliancy of the fruit tree species investigated. Analysis of the quantitative anatomical indices of blades failed to confirm the progressive increase in the numerical coefficient found in the literature; the coefficient of correlation between palisading and

sponginess of tissue, and the regular decrease in the percentage of transventilation with increase in the smoke resistance of plants. Only in the mulberry do the xermorphic indices correlate with the corresponding stomatic apparatus indices. The presence of gas causes the degree of transventilation to decrease in each of the species. There is a tendency to strong cutinzation, and to consolidation of palisade cells, when sulfur gas is present.
Source: 1

#1633
Nishino, O., M. Arai, I. Senda, and K. Kubota. "Kankyo osen no suzume ni oyobosu eikyo." (Influence of environmental pollution on the sparrow). Nippon Koshu Eisei Zasshi (Japan J. Public Health), 20(10): 1 p. (Oct 1973).

To examine the possibility whether sparrows could be used as the index of pollution by heavy metals, sparrows were caught in a cadmium polluted area near a refinery, and in two areas where the itai-itai disease occurred. Five sparrow livers from each polluted area were studied for Cd, mercury, zinc, copper, and lead, and then compared to livers from control sparrows. The values obtained near the refinery were 3.1, 0.1, 14.3, 2.7 ppm, and N. D., respectively. Values obtained in the itai-itai disease area were 1.8-1.6, 0.2-0.2, 3.1-10.7, 2.6-2.0 ppm and N. D., respectively. Average values for the control areas were 0.47, 0.1, 9.5, 2.4, and N. D. ppm, respectively. The average value of Cd in the polluted areas were 2.2 ppm, which is significantly higher than the 0.47 ppm average of the unpolluted areas. Cadmium values in unpolished rice were lower in the refinery area in actuality, whereas the analysis of Cd in the sparrow livers showed a higher content than in the areas of itai-itai disease, because the birds are easily influenced by Cd in the air. Mercury resulting from residual fungicide pollution showed no difference in the sparrows from polluted or control areas. The aparrow can be used as the pollution index because of its short life and its sensitivity to heavy metals.
Source: 1

#1634
Nobel, P.S. and C.T. Wang. "Ozone increases the permeability of isolated pea chloroplasts." Arch. Biochem. Biophys., 157(2):388-394 (1973).

The effect of short-term exposure of chloroplasts isolated from the leaves of Pisum sativum (peas) to high concentration of ozone was examined. The inhibitory effect of O_3 on endogenous photophosphorylation was apparently related to an increased permeability of the chloroplast limiting membranes induced by O_3 exposure. A 5-minute treatment with 50 ppm O_3 reduced the reflection coefficient of meso-erythritol from 0.84 to 0.58 and that of glycerol from 0.26 to 0.03. Such decreases in reflection coefficients indicate that O_3 caused a marked increase in the permeability of the limiting membranes of the chloroplasts which may result from an oxidation of membrane lipids. The decrease in the reflection coefficient of meso-erythritol was proportional both to O_3 concentration (up to 30 ppm for 5 min of bubbling) and to time (up to 5 min at 30 ppm). Extrapolating these results to lower concentrations and longer times, O_3 injury should be possible for a 2 hour exposure to plants to 0.3 ppm O_3, as is indeed the case.
Source: 1

#1635
Noller, B.N. and L.E. Smythe. "Distribution of lead in vegetation bordering roads in the Sydney metropolitan area." Search, 5(3):108-110 (March 1974).

A survey on the distribution of lead in vegetation bordering roads in the Sydney, Australia metropolitan area is summarized. Samples of plants were taken from six sites covering a range of daily traffic volumes from Oct. 1971 to July 1972. All samples were taken from the same sites within 20 ft. of the roadway except for an area of virgin bushland, away from traffic. Each plant sample was divided into two, and one half was washed in 0.1% solution of non-ionic detergent and rinsed four times in distilled water; the remaining half was left unwashed. The results from all sites are tabulated. In nearly every case the value of the washed sample is lower indicating removal of material adhereing to the plant surface. Careful washing reduces the Pb content to levels about equal to those observed some distance from the highway. The effectiveness of washing techniques in removing Pb from plants was related to the nature of the plants surface.
Source: 1

#1643
Nouchi, I., and T. Odaira. "Ozone no shokubutsu shikiso ono eikyo." (Influence of ozone on plant pigments). Text in Japanese. Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(2):120-25 (August 1973).

Plants exposed to 20 ppm of ozone for 6 hr/day showed symptoms of damage including bleaching, chlorosis, and discoloration of leaves. The appearance of reddish-brown and reddish-purple pigment on the leaves of zelkova and morning glory leaves, respectively, was due to an anthocyanin pigment. The total chlorophyll content and the ratio of chlorophyll a to chlorophyll b decreased with the increased length of exposure to O_3. Ozone accelerated the aging of the plants by decreasing the chlorophyll content and the a/b chlorophyll ratio.
Source: 1

#1640
Nouchi, I., and T. Odaira. "Effects of ozone on plant pigments." In: Annual Report of the Tokyo Metropolitan Research Institute for Environmental Protection, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), p. 23-32 (1974).

The effects of ozone on plants were studied, with emphasis on leaf bleaching, chlorosis, and appearance of reddish flecks on leaves. Leaves were analyzed with emphasis on ozone-induced destruction of chlorophyll and the formation of red anthocyanin pigments. Leaves were exposed to 20 pphm to O_3. Pigments in Brassica pekinensis, morning glory, Zelkova serrata, and Prunus yedoensis were analyzed. Exposure to O_3 decreased the amount of chlorophyll, lowered the ratio of chlorophyll a to chlorophyll b, and caused anthocyanin to form. From these results and from symptoms of O_3 injury to broad leaves (such as early appearance of yellow or red pigments in the leaves and premature fall of leaves), and published microscopic observations of chloroplast, it was deduced that O_3 accelerated the senescence of leaves and of the plant itself.
Source: 1

#1639

Nouchi, I., and T. Odaira. "Ozon ni yoru shokubutsu shikiso eno eikyo." (The effect of ozone on plant pigments). Text in Japanese. Tokyo-to Kogai Kenkyusho Nenpo (Annu. Rept. Tokyo Met. Res. Inst. Environ. Prot.), 5:56-51 (March 1974).

Leaves of Zelkova and Prunus yedoensis continuously exposed to 20 pphm ozone for 17 and 24 days remarkable reductions of total chlorophyll. Zelkova leaves showed a reduction of 1.958 mg/g from 3.667 mg/g, and P. yedoensis leaves were reduced from 4.277 to 2.569 mg/g chlorophyll. The ratio of a/b chlorophyll and the formation of antocyan pigment were also affected. Visible damages such as reddening or yellowing of leaves and early leaf fall, plus electron microscopic examinations of chloroplasts, prove ozone-induced necrosis of the leaves and eventually of the tree.
Source: 1

#1638

Nouchi, I. and T. Odaira. "PAN no shokubutsu higai shojo." (Symptoms to be observed in plants damaged by peroxyacetyl nitrate). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 599-606 (March 1974).

Peroxyacteyl nitrate was synthesized to conduct exposure tests to determine the symptoms of plants injured by PAN. Exposure rooms, equipped with two propel fans, consist of artificial meteorological twin rooms made of almite, glass, and stainless steel with an inner volume of 0.6 cu m. The concentration of PAN was measured at intervals of 20 min. Temperature was 30 C with humidity 45 or 90%. Decreases in PAN concentration were not affected by humidity and PAN remained stable for 3 hr in the chamber. A decrease in PAN concentration was measured by employing petunia, zelkova, morning glory, and haricot bean planted in pots. The decrease in PAN concentration was linear, reaching half of the original value in 30 min. Damages by PAN were not observed(with the exception of haricot bean and tomato) during the exposure test, but in many cases they appeared on the following day. The extent of damages depends upon the type of plants, concentration of PAN, the growth stage, and the environmental conditions. Glazing appeared in reverse leaves of plants, followed by bronzing. Silvering was not as marked. In the case of Swiss Chard,damages were limited to young leaves in which small black-brownish flecks appeared in the upper surface. Damages to tomato were also limited to young leaves. Black necrosis flecks appeared between veins adjacent to the range of leaves in the upper surface, while the lower surface showed blackish browning.
Source: 1

#1642

Nouchi, I., and T. Odaira. " Taiki osen-shitsu no shokubutsu yoshikiso eno eikyo." (Influence of air pollutants on pigments in plant leaves). Text in Japanese. In: Studies on Tokyo Smog. Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 573-584 (March 1974).

Potted plants of morning glory, kidney beans, poplar, cherry, zelkova, and platanus were exposed to ozone and sulfur dioxide in an artifically weather-controlled room. After and/or before the exposure, chlorophyll, carotenoid, and anthocyan were extracted from the plant leaves, and the change of these plant pigments were studied. After exposure to 15 pphm ozone for 5-12 hr the total quantity of chlorophyll decreased and also the ratio of chlorophyll b decreased. Carotenoid in cherry leaves increased after ozone exposure, however, kidney bean and platanus leaves showed no change. Formation of anthocyan (recognized by its aglycone) in zelkova and morning glory leaves exposed to ozone was confirmed, the aglycone being identified as cyanidine and the sugar as glucose. After exposure to SO_2 at 40-50 pphm for 18 hr (6 hr/day, 3 days), the chlorophyll and the ratio of chlorophyll a/b also decreased. Carotenoid was not affected by SO_2. Ozone accelerate the senescence of plant leaves.
Source: 1

#635

Nouchi, I., T. Odaira, and T. Sawada. "Taiki osenshitsu no shokubutsu shikiso e no eikyo." (Influence of air pollutants on plant pigments). Text in Japanese. (Presented at the Japan. Society of Air Pollution, Annual Meeting, 14th, Fukkushima, Japan, Paper 59, Nov. 6-8 1973). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):309 (Oct. 1973).

The changes in chlorophyll and carotenoid of plants exposed to ozone and sulfur dioxide are reported, after experimental exposures. Potted kidney beans were exposed to 15 pphm of ozone and 45 ppm of SO_2; O_3 concentrations were continuously measured by chemiluminescence and electroconductivity automatic meters. Chlorophyll was extracted by 80% acetone, centrifugally separated, and measured by spectrophotometry. Carotenoid was extracted by methanol and petroleum and petroleum benzene, separated into the ethanol layer and the benzene layer, the benzene layer being carotene. Carotene and xanthopyll were extracted and measured by spectrophotometry. The result showed that the total chlorophyll of the control group was 1.711 mg/g and the exposed group, 1.512 mg/g; the ratio of chlorophyll d/b was 3.31 for the control group and 1.65 for the exposed group. Carotenoid quantity showed almost no change; but the ratio of xanthopyll/carotene tended to increase.
Source: 1

#1641
Nouchi, Isamu, Toshio Odaira, Tadashi Sawada, Kuniko Oguchi and Tetuhito Komeiji. "Ozon ni yoru shokubutsu higai shojo." (Plant ozone injury symptoms). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 8(2):113-119 (Aug. 2, 1973).

A study of the phytotoxicity of ozone to plants was conducted in controlled atmosphere greenhouses to determine if the symptoms of such exposure would be similar to symptoms exhibited by plants expcsed to photochemical smog (which contains ozone) in the Tokyo area. Test plants included herbaceous and woody plants, which were fumigated to 20 pphm ozone. Plants used as controls for the ozone exposure experiments were placed in a carbon filtered greenhouse. Herbaceous plants were generally sensitive to injury, especially Brassica rapa and Brassica pekinensis. Woody plants were rather resistant except for the poplar. Depending on plant species and the severity of injury, ozone-injury symptoms of the herbaceous plants included bleaching, chlorosis, necrosis, and reddish-brown flecks. Leaves of woody plants developed discreet punctate spots, reddish-brown pigment on the upper surface and defoliation. Ozone injury was typically confined to the upper leaf surfaces and notably maturer leaves. Microscopic examination showed that pallisade cells were more prone to ozone injury than other tissues.
Source: 1

#1548
Nouchi, I., T. Ohashi, and T. Odaira. "Taiki osen no shokubutsu ni oyobosu eikyo; kakusan, tanpakushitsu e no ozon no eikyo." (The effects of air pollutants on vegetation - the effects of ozone on nucleic acid and protein). Text in Japanese. (Presented at the Japan. Society of Air Pollution, Annual Meeting, 14th, Fukushima, Japan, Paper 58, Nov. 6-8 1973). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):307 (Oct. 1973).

How ozone affects the nucleic acid and protein in plant leaves was investigated. A potted cherry tree was exposed to 15 ppm O_3 gas for 6 hr each during the daylight hours in a exposure chamber, and the amounts of nucleic acid and protein during the exposure treatment were quantified and compared with those of the control plant. After 9 hr of exposure, the leaves began to show numerous red-brown spots, and at about the same time, the amount of nucleic acid and protein began to drop sharply. Nucleic acid dropped to 64% of the normal amount in 12 hr and protein dropped to 60% in 12 hr.
Source: 1

#1637
Nouchi, I., T. Ohashi, T. Sawada, T. Odaira, M. Hikima, and M. Iwanami. "Jumoku ni taisuru ozon to nisanka io no fukugo gasu no eikyo." (Effects of combined gas composing of ozone and sulfur dioxide on treas). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 594-598 (March 1974).

Potted plants 2-3 yrs old were exposed respectively to 15 pphm of ozone, to 45 and 75 pphm of sulfur dioxide, and to a combined gas composed of 16 pphm of ozone and 18 pphm of SO2 in an artificially weather controlled room. The damage from ozone consisted mainly of small spots on the surface of grown leaves. The damage appeared most early on Caroline poplar (9 hr exposure), then on cherry, platanus, and Cersis (18 hr), and did not appear on Acer buergeriana, Querchus myrsinaefolia, Pinus thunbergii and Ginko biloba (60 hr). The symptoms of SO2 damage consisted of large necrotic spots between the veins and periphery of grown leaves and of reddish brown spots on grown leaves appearing 6-12 and 12-18 hr after exposure to 75 and 45 pphm, respectively. The damage appeared on all the trees except Acer buergeriana. After exposing trees to the combined gas for 4 days the damage appeared most early on Salix babylonica, then on Calorine poplar, followed by platanus, and by cherry (Prunus yedoensis). Damages appeared after 24 hr of 4 days exposure on Pinus thunbergii. The appearance of damage is accelerated by coexposure to ozone and SO2 and the enlarged damages thereby. It could not be determined whether the results were additive or multiplicative.
Source: 1

#1636
Nouchi, I., T. Sawada, K. Kan, T. Ohashi, T. Odaira, T. Iijima, K. Terakado, M. Hikima, M. Iwanami, and S. Sugata. "Ozon ni taisuru shokubutsu no sotaiteki tekiosei." (Relative resistibility of plant to ozone). Text in Japanese. In: Studies on Tokyo Smog. Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 585-593 (March 1974).

The results of experiments on the susceptibility and resistance of plants to ozone conducted between June 1972 and August 1973 are presented. Various species of trees, grass, vegetables, flowers, and beans were exposed to various concentrations of ozone from an ozone producer in an exposure chamber. The two basic concentrations were 15 pphm and 20 pphm. Different relative resistances of plants manifested themselves in terms of the time and concentrations required for visible damages and in degrees of damage by the same concentration and exposure time. Large trees (woody plants) have higher resistance to ozone than annuals and other types of grass (herbaceous) plants. The most susceptible plants among the grass and vegetables were alfalfa, spinach, and small-leaf Chinese cabbage. Turnips and tomatoes had medium resistance and geranium and gladiolus had high resistance. Geranium did not show any damage from the 48 hr exposure to 15 pphm of ozone, but necrosis appeared in 6 hrs when exposed to 60 pphm of ozone.
Source: 1

#636
Novakova, E. "Indicateurs biologiques et leur valeur dans le controle des deteriorations de l environement." (Bioindicators and their value in the control of envrionmental deterioration). Text in French. TERPLAN-Statni ustav pro uzemni planovani. Ustav krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiny, Shortnik Z. Mezinarodni Konference, Prague, Czechoslovakia, p. 5-13 (1971).

Problems and significance of bioindicators of environmental pollution are outlined. Non-vascular epiphytes are used for the determination of the degree and extension of air pollution. The use of plants and animals as bioindicators for the diagnosis of the hygienic aspect of the environment, though very promising, is in an experimental stage. For complex studies of environmental degradation, species and groups of species, usable in a major part of the temperate climatic zone, should be selected. Synergism, inhibition, and antagonism in the action of environmental pollutants on bioindicators, changes in the susceptibility of the latter to pests, adaptation and sensibilization are among the factors complicating the use of bioindicators. The physiologic barrier to the penetration and assimilation of noxious agents into the bioindicator organism is constituted mainly by epithelial tissues. Silvery, vitrous, bronze, or metallic coloration of the inferior surface of plants is indicative of peroxyacetylnitrate.
Source: 1

#1218
Nowak, G. and J. Czapla. "Badania nad pobieraniem i przemieszczaniem siarki znakowanej izotopem ^{35}S w siewkach sosny pospolitej (Pinus silvestris)." (Investigations on absorption and translocation of sulphur marked with isotope ^{35}S in seedlings of Scotch Pine *(Pinus silvestris)*. Sylwan, 10: 43-49 (1971).

The authors examined the absorption and translocation of sulphur, applied to needles and roots, by 2-year-old pine seedlings *(Pinus silvestris)*. They stated the possibility of absorption by needles of sulphur and its translocation to other organs. A great share of sulphur taken in this way was accumulated in the root system, especially in its growing part and in that being in symbiosis with the fungus. A part of examined element was diffused into the medium. At application of sulphur to roots of seedlings, it was mostly accumulated in the needles and at application to needles - in roots.
Source: 6

#383
Numata, M. "Kankyo hozen eno seitai gakuteki sekkin-tokuni seibutsu shihyo no tsuite." (Ecological approach to environment preservation especially on the biological indicators). Text in Japanese. Chiba Daigaku Kankyo Kagako Hoku-ku (Rep. Environ. Res. Organ., Chiba Univ.), 1(2):231-236 (Dec. 1973).

General concepts of biological and plant indicators are discussed. Plant species which are very susceptible to environmental pollution and plant species which are relatively resistant to air pollution yet are affected by the pollution are discussed as pollution indicators. The change of ecosystem is an indicator of urbanization and air pollution. Some indicator plants would be useful as pollution-removing agents.
Source: 1

#890
Nuttonson, M.Y. (ed.). "Effects & symptoms of air pollutes on vegetation; resistance and susceptibility of different plant species in various habitats, in relation to plant utilization for shelter belts and as biological indicators." In: AICE Survey of USSR Air Pollution Literature, Vol II (1969).

19 papers by Soviet authors - Reports in this volume deal with various aspects of air pollution and vegetation, in areas throughout the USSR. Contamination of the environment is a major problem in all of USSR's industrial regions. There are continuous changes in the habitat through an ever-increasing pollution of the air, soil, and water. There has been a greater awareness of these problems, and protective measures against the pollution threat are gradually taking shape. There are increasing amounts of relevant air pollution research data being developed and put to good use.
Source: 8

#889
Nuttonson, M.Y. (ed.). "The susceptibility or resistance to gas and smoke of various arboreal species grown under diverse environmental conditions in a number of industrial regions of the Soviet Union." In: AICE Survey of USSR Air Pollution Literature, Vol III (1970).

15 papers by Soviet authors - Reports in this volume deal with various aspects of air pollution and vegetation, in areas throughout the USSR. Contamination of the environment is a major problem in all of USSR's industrial regions. There are continuous changes in the habitat through an ever increasing pollution of the air, soil and water. There has been a greater awareness of these problems, and protective measures against the pollution threat are gradually taking shape. There are increasing amounts of relevant air pollution research data being developed and put to good use.
Source: 8

#229
Nyborg, M., and McKinnon, Allen & Associates, Ltd. "Atmospheric sulphur dioxide: effects on the pH and sulphur content of rain and snow: addition of sulphur to surface waters, soil, and crops: and acidification of soils." Environment Canada, Edmonton (Alberta), Canadian Forestry Service and Northern Forest Research Centre, and Alberta Environment, Research Secretariat, Proc. Workshop Sulphur Gas Res. Alberta, Edmonton, Alberta, p. 79-97 (1973).

The deposition of sulfur dioxide on the earth was studied. Objectives of the study were to find if SO_2 emissions acidify precipitation, soils, and water under Alberta conditions; and to determine the amounts of SO_2 adsorbed directly by vegetation, soils, and water at different distances from gas plants in Alberta. In 1972, 12 stations were established near the Shell Waterton gas plant which has a maximum emission of 124 long tons/day of sulfur. Eleven stations were close to the plant, and one control station was 25 mi away. In 1973, the number of stations was increased from 12 to 19, and 59 additional stations were established in other areas of Alberta. Four control stations

were placed in Saskatchewan. Thirteen were located near the Aquitain Ram River gas processing plant which emits 84 long tons of S per day. Rain and snow were analyzed for pH, sulfate, calcium, magnesium, sodium, potassium, ammonium, and nitrate. The effects of the emissions on soil pH and sulfur added to the soil were also studied. Absorption of sulfur emissions by water was estimated in experiments near the Waterton and Ram River plants in 1973. The sulfur emissions were brought to earth through direct absorption by soils, vegetation, and water, as well as by deposition in rain and snow. The amounts of S deposited in rain were very small, and the problem of acid rain was much less severe than in heavily industrialized parts of the world. The soils downwind from emission sources received enough S (primarily through absorption) to cause gradual lowering of soil pH.
Source: 1

#1240
Oak Ridge National Lab., Tenn., Environmental Sciences Div. "Heavy metals in a forest impacted by a lead mining-smelting industry." In: Environmental Sciences Division Annual Progress Report. Rept. 653, UC-48, p. 94-100 (March 1975). NTIS: ORNL-5016.

Heavy metal emissions from lead sintering and smelting operations in the forested Crooked Creek Watershed area of southeastern Missouri were studied. Baghouse dust characterizations revealed that cadmium and zinc concentrations were higher in smelting dusts than in roasting-sintering dusts. Lead sulfide appeared in dusts from both sources, while lead sulfate and lead oxide appeared only in dusts from the sintering operation. Cadmium concentrations decreased with increasing particle size, whereas lead concentrations were not affected by particle size. The occurrence of high levels of Cd, copper, Pb, and Zn inorganic litters of Crooked Creek indicated that this component of the forest may be the most important biological sink for these contaminants. Cadmium was much more soluble in the organic litter layer than Pb; Cd was also more available for vegetative uptake.
Source: 1

#1644
O'Connor, J.A., D.G. Parbery, and W. Stauss. "The effects of phytotoxic gases on native Australian plant species: Part 1. Acute effects of sulphur dioxide." Environ, Pollut., 7(1):7-23 (1974).

The relative susceptibility to acute sulfur dioxide injury was determined for seedlings of 131 Australian tree and shrub species, many widely used in urban plantings. The plants were fumigated in an exposure chamber with concentrations of 0.3, 1, 2, and 3 ppm SO_2. Durations of fumigations were 0.5, 1, 2, 4, and 6 hrs at 3 ppm SO_2; 3 and 6 hr at 1 ppm; and 27 hr at 0.3 ppm. Acute injury occurred in sensitive species of Eucalyptus and Acacia after a 3-hour exposure to 1 ppm. Of the species tested, Eucalyptus was the most sensitive and Casuarina the most resistant. Other genera studied included Acacia, Banksia, Callistemon, Callitris, Hakea, and Melaleuca.
Source: 1

#1645
Odaira, T., T. Sawada, T. Komeiji, I, Nouchi, K. Oguchi, K. Negishi, M. Iwanami and T. Asaka. "Damage to vegetation when exposed to ozone and high oxidant concentrations." Tokyo-To Kogai Kenkyusho-ho (Ann. Rept. Tokyo Metropol. Res. Inst. Environ. Protection), p. 25-35 (1973).

Ozone exposure tests on 15 herbaceous plant species and eight woody plant species were conducted in twin artificial meteorological rooms with temperature and humidity control equipment in order to examine plant damage at high oxidant concentrations (20 plus or minus 5 pphm ozone). Woody plants were found to be generally more resistant to ozone than herbaceous plants, and resistance varied depending on the stage of growth. Brassica rapa B. Pekinensis, soybean, and alfalfa showed the weakest resistance among the herbaceous species, while cauliflower, Welsh onion, and corn showed the strongest resistance. Poplar was found to be the least resistant among woody plants, while deodar and maidenhair tree exhibited much stronger resistance. The most conspicuous leaf injury symptoms for herbaceous plants were leaf flecks of the bleaching type. Small grey-brownish or dark brown flecks were observed on soybean leaves; and morning glory leaf damage was rather complex, a change having developed in the color-producing system on the surface of the leaves 20-30 days after ozone exposure. Leaf injury symptoms for woody plants appeared as dark brown or red-brownish flecks on full-grown leaves of trees such as poplar, Zelkova serrata, and platanus; while another type of leaf injury was observed in the case of the cherry tree where the leaf surface turned yellow. The fact that certain types of field damage could not be produced by ozone along points to the need for further examination of the effects on plants of simple substances of various atmospheric pollutants.
Source: 1

#1646
Odaira, T., T. Sawada, T. Komeiji, I. Nouchi, T. Ohashi, N. Date, T. Iijima, and K. Terakado. "Asagao ni yoru kokagaku smoggu eikyo chosa." (Investigation of influence of photochemical smog by damage on morning glory). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 655-672 (March 1974).

Smog damage to two varieties of morning glory was investigated in Tokyo and contrasted to that in control locations. The damage appeared when the oxidant daily dose reached 60 pphm-hr, and the oxidant concentration reached 15 pphm. The first day of damage occurence was

July 2-11 with local differences. In 3 cases when high concentration of oxidant occurred over wide localities, the damage to morning glory appeared at more than 90% of the schools where morning glory had been planted. No relation was recognized between photochemical smog and decolorization spots on the leaves of the plant; however, such spots appeared at 63% of monitoring schools. The accumulated damage within two weeks from July 1 on the Scarlet O'Hara variety was more than 50% at almost all the monitoring schools. The position of damaged leaves was the 6th to 11th leaves. Local difference was observed in the percentage of damaged leaves. On the plants in a control school in Shirakawa (Fukushima Pref.) some slight damage was observed. From these findings, no pin-point phonomenon of photochemical smog was observed, and the plant damage due to existing photochemical smog of the Tokyo area presumably covered a broad area with a diameter of about 100 Km centering around metropolitan Tokyo.
Source: 1

#1647
Odaira, T., K. Shiratroi, and T. Sawada. "Nosakubutsu o chushin to shita okishidanto shokubutsu higai no yagi chosa hoho ni tsuite." (On a method of field investigation in oxidant damage to vegetation, particularly to the crops." Text in Japanese. Taiki Osen Nyusu (Air Pollution News), 76(5): 1-6 (May 1973).

To obtain more accurate information, field investigations must be designed to eliminate the possible differences caused by the individual investigator, plants, or environmental conditions. It is desirable to conduct an investigation during a short period of time since the symptoms of plant damage vary with time. A method was proposed for investigating damage to spinaches, scallions, taros, morning glories, radishes, chinese cabbages, and Santo vegetables at 67 locations in Tokyo, China, Saitama, and Kanagawa. The degree of damage was classified into 0%, 1%, and 2% which indicated no injury, 10% and 20% injuries. The investigations were to be carried out twice a year in June and August, 48 hours after the occurrence of photochemical oxidants. The recording methods were by investigation cards and photographs.
Source: 1

#637
Oden, S. "Some effects of the acidity of air and precipitation." (Int. Air Pollut. Control Noise Abatement Exhib. Conf. Jonkoping. Sept. 1-6 1971). p. 1:85 to 1:94.

Europe has an acidification problem with widespread effects on soil, biological and technical systems, and on the health of man. In 1956, the acidification center in Europe with a pH value less than 5.0 occurred over eastern England, Holland, and Belgium. Large parts of Scandinavia had almost neutral precipitation. In 1959, the less than pH 5.0 area had extended greatly, particularly in the north-easternly direction. A new acid class, less than pH 4.5 occurred over northern Germany, Holland, and Belgium. In 1961 and 1966

the annual precipitation within the center had an acidity of less than pH 4.0. Yearly variations show that the air is more acid during the winter period than at other times. Measurements in Swedish lakes and rivers show that the pH value in a large number of Swedish rivers has constantly dropped during the years 1965 to 1970. Changes have been greatest in southern and central Sweden, within the area where the precipitation has been the most acid. Acid precipitation falling on soils leads to a depletion of the nutrient supply in the soil, and to reduced pH values. The turnover time for soil cations, including sodium, potassium, calcium, and magnesium, due to the fallout of acids was calculated to be 40 to 70 years. Assuming 60 years, the half-life for the inventory of cations will be approximately 40 years. The cumulative effect of sulfur dioxide on coniferous trees leads to a decomposition of the chlorophyll since the life time of the needles is up to 7 years. Lichens have proven to be a sensitive indicator of sulfur dioxide in the air. Since pH of precipitations is less than 5.5 for most of Europe, nitrogen fixation by blue-green algae is interfered with especially at more exposed positions.
Source: 1

#1255

Oden, S., and R. Anderson. "The longterm changes in the chemistry of soils in Scandinavia due to acid precipitation." Preprint, Agricultural College, Uppsala, (Sweden), Dept. of Soil Science, 20 p. (1973).

The long-term changes in the chemistry of soils in Scandinavia due to acid precipitation were investigated. The areal distribution of soil pH in the a-layer (0-5 cm) is illustrated. Soils with a pH less than 3.4 form an almost continuous zone along the Scandinavian coast to the Southwest. A small area appears in the middle of Sweden where alum shale has been burnt for some decades. A third area is located in the north of Sweden where pH values higher than 4.0 appear. The distribution reflects regional influence from the central European acidification center and locally from sources in the vicinity. One source was formed as a result of emissions of sulfur dioxide from pulp industries along the Swedish coast to the Baltic Sea during more than 50 yr. An additional effect may be due to the land rise along this coast, 1 m in 100 yr, resulting in exposure of hydrogen sulfide containing soils. Hydrogen sulfide will then vaporize, be oxidized in the atmosphere by SO_2 and sulfuric acid, and finally be brought down to the ground in the surroundings. The top soil will consequently be acidified.
Source: 1

#1124

Odum, E. P. "Ecological principles and the urban forest." p. 78-81 In: Symposium on the Role of Trees in the South's Urban Environment, January 31-February 3, 1971, Athens, Ga. University of Georgia. Center for Continuing Educ., 105 p. (1971).

A tree may be considered "protective" as well as "productive" vegetation. A tree provides wood, pollution abatement, etc. The author stresses that diversity, correct selection of species that will adapt to a specific environment, and natural disease resistance, low maintenance, and preservation of the understory are factors that lead to the successful growth and maintenance of an urban forest. There is a table which compares ecological characteristics of commercial forests and protective green belt vegetation.
Source: 8

#575

Oelschlaeger, W. "Fluoride in food." Fluoride, 3(1):6-11 (Jan. 1970).

The results of fluoride assays in food, in the vicinity of fluoride-emitting factories and under normal conditions, are presented. Lettuce and spinach contain more fluoride than other vegetables; sweet cherries more than other fruits. In peas, 200 times more fluoride was found in polished than in unpolished peas. The fluoride content of polished rice was 50 times higher than that of unpolished rice. Food derived from animals was higher in fluoride than that which originated from plants. The largest amounts were found in fish. A person eating an average daily diet would consume between 0.3 and 0.4 mg of fluoride. The addition of polished peas and rice, tea, and fish may raise the daily average intake to above two milligrams. Foods from areas near fluoride-emitting factories has much higher fluoride levels than the uncontaminated areas. Near a hydrofluoric acid factory, milk contained 5.7 ppm, compared with 0.05 ppm fluoride in non-contaminated areas.
Source: 1

#638

Oelschlaeger, Walter. "Problematik der Immissionsmessungen von Fluor hinsichtlich der Wirkungen auf Pflanza und Tiner." (The problems of emission measurements of fluorine concerning the effects on plant and animal). Staub, Reinhaltung Luft, 31(11):457-459 (Nov 1971).

The fluorine content of the ambient air can be determined by two methods: either the gaseous fluorine compounds are determined or the gaseous F compounds plus the F compounds contained in the fly ash are determined. Plant damage is almost exclusively caused by the gaseous F compounds in the atmosphere. Industries emit mostly hydrogen fluoride and silicon fluoride. These gases are easily absorbed by plants through the stomata. The damage caused by fluorine compounds found in fly ash on plants is minimal. This can be confirmed by experiments with apple, pear, and cherry trees and with lilac. The soil in which the plants grew contained 1.5 g/kg fluorines and the fly dust applied to the leaves contained 12 g/kg and 132 g/kg. After weeks of application, no injuries could be observed. Apart from the gaseous F compounds in the atmosphere, resistance, water metabolism, nutrient supply, relative humidity, and light intensity must be taken into consideration. Cattle are most sensitive to higher fluorine intakes. Fluorine compounds are either ingested with food or drinking water or inhaled. Cattle's tolerance limit for fluorine intake with the fodder is 30 to 40 ppm referred to dry substance, which is less than one mg/kg body weight. Experiments have shown that higher F concentrations in hay hardly raised the F content in bones above that in cattle receiving sodium fluoride. The same is true for the F intake from fly dust adhering to grass. Therefore it is better to use only the measurement of gaseous emissions for any evaluation of the injurious effect of fluorine. The F content on and in plants should be seperately determined by the carbon tetrachloride method.
Source: 1

#639
Oelschlager, W. "Determination of fluoride standards for vegetation and animals." Fluoride, 5(3):111-114 (July 1972).

In determining fluoride emission standards with respect to possible damage to vegetation, better results are obtained if gaseous fluoride is considered exclusively. However, in evaluating damage to animals fluoride uptake in gaseous or through respiration is negligible compared with uptake through forage, soil, and fly ash. Soil and fluoride, emitted with fly ash near factories, is attached to raw forage such as grass, clover, and alfalfa. Since the amount of fluoride in soil is approximately 20 to 150 times as high as the fluoride content of forage and that of fly ash is more than 1000 times as high, the question arises as to whether or not the solid particles should be considered when measuring emissions. When nearly identical supplements of fluoride, namely 72 ppm, in the form of soil, sodium fluoride, and fly ash from an aluminum factory smelter, were administered to cattle, the fluoride uptake from soil was 0.7 times, from fly ash 1.4 times, and from sodium fluoride 3.0 times as high in the experimental animals as in those which received the fluoride supplement. The utilization of fluoride derived from soil in ruminant animals is highly variable depending on the origin of the soil. The fluoride from soil and fly ash is more or less available, although at lower magnitudes, than fluoride contained in forage. However, if for establishing emission standards, particulate fluoride in addition to gaseous fluoride is being considered, values can be obtained which are not in accord with the possible damage to animals. Thus, damage to health may be more extensive with a relatively low gaseous emission than with a high level depending on the proportion of fluoride in the gaseous and particulate form. As a maximum value for fluoride content of forage, 40 ppm/day is being considered for high productive cattle. This value, however, is not only reached, but occasionally substantially exceeded, in non-polluted areas; because of the top permissable fluoride levels in phosphate-containing feed.
Source: 1

#1649
Oelschlaeger, W. "Die Problematik bei der Probeentnahme von Futtermittein in und ausserhalb von Emissionsgebieten." (The problems involved in sampling within and outside zones of emission). Landwirt. Forsch. Sonderh., 26(1): 89-99 (1973).

Problems involved in the sampling of plant materials both inside and outside emission zones are considered, especially in regard to trace element analysis. The basic problem revolves around obtaining as accurately as possible an average sample of actual composition. Elimination of error possibilities requires a knowledge of such factors as botanical composition, vegetation stages, rains, mass losses in leaf and blossom parts, contamination through the soil, and gaseous or particulate emissions. Sampling and preparation of samples is also considered with respect to quantitative aspects of trace element analysis.
Source: 1

#1648
Oelschlaeger, W. "Fluorschadenswirkungen." (Harmful effects of fluoride). Text in German. Ziegelind (Wiesbaden), 4:169-174 (1974).

Studies and observations on the harmful effects of fluoride emissions from various industrial sources on plants and animals are reviewed. Fluorine, hydrofluoric acid, and other gaseous fluorides are most dangerous to plants, and especially to Conifera. Entering through the stomata such fluorides cause necroses and interfere with metabolic processes. The harmful effects are influenced by such factors as solar raidation, water budget of the soil, relative humidity, and fertilization. Fluorisis in cattle, manifesting itself in bone lesions such as periostal hyperostosisand exostoses, and causing production losses, is due to fluorine present in and on plants ingested, The fluorine tolerance for cattle is proposed to be set at 40 ppm in forage.
Source: 1

#640
Oelschlaeger, W. and E. Schwarz. "Feblermoeglichkeiten und deren Eliminierung bei der Bestimmung von Blei mittels Dithizon in biologischen Substanzen." (Sources of error and their elimination in the determination of lead in biological substances by means of dithizone). Z. Anal. Chem., 258(3): 203-207 (1972).

Dithizone forms with lead a carmin-red primary dithizonate both in weakly acid as well as in alkaline solution. The dithzonate can be easily extracted in chloroform. The extraction from citrate and cyanide containing solutions is complete only from a pH of 9 onward. Citrate is mostly added for prevention of a precipitation of phosphates, and cyanide is added for elimination of interferences of most of the heavy metals reacting with dithizone. The largest interference is caused by Bismuth (Bi). An examination of the average Bi and Pb concentrations of samples from areas with and without emissions revealed that Bi concentrations are generally higher in areas with air pollution than those from areas with none. A Bi separation is not necessary in such cases because the Pb concentration are also markedly higher, e.g., spruce needles from an air polluted area contained 0.19 ppm Bi and 18 ppm Pb, they contained 0.02 ppm Bi and 3 ppm Pb from an area without air pollution. A separation of Bi is required, however, in the case of samples taken from the vicinity of factories processing sulfur-containing ores. The best and quickest method of separation is that using diethylammonium-N, N-diethyldithiocarbamate. For the determination of lead, it should be taken into account that the reagents sodium, ammonium citrate, and hydrofluoric acid are contaminated with relatively high amounts of lead. Pure chloroform is used as a blank solution, since the extracted blank solution is not stable, even in darkness. Sources of error in ashing are also discussed; a method is described which can be carried out rapidly and is reproducible.
Source: 1

#1651
Ohara, A. "Jumoku no kogai boshi shiken 1. Taiki osen no jumoku ni oyobosu eikyo." (Experiments on protecting trees from environmental pollution. Part I: The influence of air pollution on trees). Text in Japanese. Fukui-ken Ringyo Shikenjo Hokoku (Annu. Rep. Fukui Prefect. For. Exp. Stn.), 11:185-189 (1973).

The amount of exhaust and dust emitted from vehicles is generally larger during stopping, starting, and slow driving due to traffic jams than in high speed running; the degree of air pollution was therefore investigated by measuring the amount of dust deposited on the leaves of streetside trees near a road crossing in Fukui City. The species investigated was Magnolia kobus and four to 13 leaves per plant were collected at the same height from the ground within an area of 500 m. The dust was washed with water, recovered by evaporation, air dried at 105 C, and calculated per 100 sq. cm of leaf-surface. Dust gradually increased on the trees 200 m from the crossing reached the maximum just before the crossing, reaching a second maximum at 330 m from the crossing, and then decreased slowly. The average number of cars passing the crossroads was 7835/hr from 8:00 am to 6:00 pm. The maximum and minimum of dust per 100 sq cm were respectively 134.5 and 7.9 mg during the investigation for 3 consecutive years.
Source: 1

#1650
Ohara, A. "Jumoku no kogai boshi shiken. 2. Ryokuchi jushu no seiiku shiken." (Experiments for protecting trees from environmental pollution. Part II: Growth test of tree species). Test in Japanese. Fukuiken Ringyo Shikenjo Hokoku (Annu. Rep. Fukui Prefect. For. Exp.Stn.), 11:190 (1973).

In order to identify plant species resistant to automobile-emitted exhaust and dust, six species of treeswere transplanted along a national road in Fukui City on March 27, 1973. The growth of these trees will be observed at appropriate intervals. The species were Ternstroemia japonica (0.53 m average height and 1.12 cm average diameter), Camellia sasanqua (1.18 m and 1.4 cm), Juniperus chinensis (1.20 m and 1.89 cm), Rhododendron indicum (0.32 m and 35 cm), another species of Rhododendron (0.40 m and 40.0 cm), and another species of Juniperus (0.26 m and 22 cm).
Source: 1

#1652
Ohira, Toshio, Tadashi Sawada, Tetsuto Komeiji, Isamu Nouchi, Kuniko Oguchi, Hou Negishi, Motoki Iwanami, and Toshio Asaka. "Shokubutsu no O3 bakuro to konodo okishidanto hasseiji ni mirareru higai jokyo." (Plant damages by O3 exposure and by high concentration oxidants). Tokyo-to Kogai Kenkyusho Nenpo (Annu. Rept. Tokyo Met. Res. Inst. Environ. Prot.), 4:99-106.

Experiments of plant damage by high concentration oxidants were conducted using an exposure chamber and ozone. Ozone created by an ozone producer was diluted by clean air, and the flow was controlled by the electric pressure control and air flow control. The ozone concentration was maintained at approximately 20 pphm at all times by the chemiluminescence automatic ozone meter. The exposure time was 6

hr daily between 10 and 4, and when no damage symptoms were noted, the operation was continued until signs appeared. The chamber temperature was 30 C during the day and 20 C during the night, and humidity was 60-90%. Light was 50-150 lux on sunny days and 5-20 lux on rainy or cloudy days. The damage conditions were classified into five levels, and also judged by the area of damages. The discoloration symptoms appeared in 3 hr on green vegetables, soybeans,and alfalfa. The most resistant plants were cauliflower, onion, and corn, which showed the symptoms in 18-42 hr. In between, turnips, lettuce, cucumbers, string beans, carrots, tomatoes, and morning glories reacted. Those with the greatest degrees of damage and the largest damage area ratio were green vegetables, cucumber, and alfalfa. Lettuce, turnips, corn, and petunia showed relatively slight damage. The resistance was generally lighter among the trees than among the annuals and vegetables. Among the trees, Carolina poplars were the most susceptible, followed by cherry, and plane trees. Himalayan cedar and ginko tree were extremely strong.
Source: 1

#1182
Ohman, J. H. "Forests and air pollution." (No publisher or date)

The article discusses forests as a source of air pollution and the various means of controlling such pollution. Some of these methods involve fire prevention,pesticide control, lumbering improvements. Also, the author points out that forests are receptors of air pollution. Examples are given of forests being injured by air pollutants. Techniques for determining the impact of air pollution on forests and also, on individual plant species are mentioned. One way to induce resistance of plants to air pollution is to locate strains less susceptible to the various air pollutants.
Source: 6

#1075
Okoneu, H., and K. Takala. "Total S content of an epiphytic lichen as an index of air pollut. and the usefullness of the xray fluorescence method in S determinations." Annals Botanici Fennici, 12(4):131 (1975).

The accumulation of sulphur in the lichen Hypogymnia physodes (L.) W. Wats. was studied around the fertilizer factory of Kemira Ltd. at Siilinjarvi, central Finland, by the isotope excited X-ray fluorescence method. The total sulphur content of the lichen varied significantly with the host tree, and showed a significant correlation with the damage index of the lichen. A close correlation was also found between the sulphur content of the lichen and that of spruce needles. The total sulphur content of lichens can be used as an index in estimating the amount of sulphurous pollutants in the air.
Source: 5

#1183

Olsen, Ralph A. "Absorption of SO_2 from the atmosphere by cotton plants." Soil Science, 84:107-111 (1957).

Cotton plants were grown in nutrient solutions containing 0.1, 2, 5, 10 and 50 ppm sulfate. Atmospheric sulfur dioxide was excluded from the roots and the sulfate in the nutrient solution was labeled with S35 to permit determination of the amount of sulfur which was absorbed by the plant directly from the atmosphere. Growth and sulfur content of the plants were sensitive functions of the concentrations of sulfate in the nutrient solutions. The data indicate that sulfur dioxide was absorbed by the growing plants directly from the atmosphere. The amount absorbed was roughly proportional to the size of the plant and was presumed to be a function of the effective leaf surface. According to the data, healthy cotton plants obtained about 30 percent of their sulfur from the atmosphere. Over 50 percent of the sulfur in sulfur deficient plants was apparently absorbed directly from the atmosphere. For satisfactory growth of the cotton plants, the sulfur dioxide of the atmosphere was inadequate as the sole source of sulfur. Nevertheless, atmospheric sulfur dioxide contributed a large percentage of the sulfur taken in by the plants, and it is concluded that, under the conditions of the experiment, absorption of sulfur dioxide provided an important supplementary source of sulfur to the growing plants.
Source: 6

#1585

Olson, J. S. "Linking atmospheric and ecosystem models for carbon budgets." In: Ecological Sciences Division Annual Progress Report. Oak Ridge National Laboratory, Ecological Sciences Div., Tenn. Pub. 385. 3 p. (Feb. 1971).

Conceptual models and mathematical models of the carbon cycle will be important in predicting the fate of carbon-14, and of excess of carbon dioxide generated by fossil fuels and other sources. The mathematical models of Eriksson and Welander first treated the subsystem of green land plants, dead organic material, and atmosphere in terms of nonlinear differential equations and concluded that these dominated changes in atmospheric CO2 over time scales of years and decades. They considered the sea primarily as a 'damping factor' of possibly greater importance for oscillations over periods of centuries or millenia. Geochemical investigations by others have used stable and radioactive isotope ratios to evaluate the compartmental exchanges between atmosphere and shallow and deep layers of the ocean. The role of vertical movements of organisms in hastening this exchange is recognized. Various data and refinements of an atmospheric compartment submodel were reviewed by Nydal. Instead of assuming a single well-mixed atmospheric compartment, several authors have distinguished the reservoirs Rs and Rt (stratosphere and troposphere, respectively, separated by the tropopause).
Source: 1

#1586

Olsson, L. E. "Lake effects on air pollution dispersion." Michigan Univ., Ann Arbor, Dept. of Meteorology and Oceanography, Grants AP-00380-03, AP-00893-01, and NIH-AP-00007, Proj. 02621, Rept. 02621-1-T, 216 p. (April 1969).

An investigation of the effects a lake and lakeshore have on the atmosphere's capability to disperse air pollution is presented. The most important effects considered are air parcel trajectories and atmospheric stabilities. Due to differences in physical characteristics between soil and water, horizontal temperature, moisture, and pressure gradients normally exist across a lake shore. When an air mass of plume is subjected to these gradients, or to the lake breeze that is likely to exist, the air mass is disturbed in some way. The results of a literature review of relevant material are presented. An observational study of a classical land and lake breeze circulation situation is discussed, and an urban area lake breeze trajectory study is descrived. The lake and shoreline effects that can influence air pollution dispersion include changes due to gradient winds, shoreline topography and geography, and urban heat island effects. Some investigations and experiments that are needed to clarify certain aspects of lake effects on dispersion are suggested.
Source: 1

#576

Ordin, Lawrence, Morris J. Garber, Juanita I. Kindinger, Sherry A. Whitmore, L. Carl Greve, and O. Clifton Taylor. "Effect of peroxyacetyl nitrate (PAN) in vivo on tobacco leaf polysaccharide synthetic pathway enzymes." Environ. Sci. Technol., 5(7):621-626 (July 1971).

Tobacco plants were exposed to one ppm of peroxyacetly nitrate (PAN) for one hr. Subsequent exposure of the plants to light caused leaf-cell collapse, which was noted after 24 hr. Assay of the leaves at that time showed a strong inactivation of alkali soluble glucan, cellulose, and lipid synthetases, no effect on phosphoglucomutase, and a stimulation of UDP glucose pyrophosphorylase. Assay of the leaves at the end of the gassing period showed no effect of the PAN except for a relatively decreased alkali-soluble glucan and cellulose synthetase activities. Plants placed in a dark chamber at that time showed no subsequent lethal effects. It was concluded that PAN treatment of potentially sensitive green plant tissue can cause nonlethal, and probably reversible, decrease of cellulose synthetase (and of growth).
Source: 1

#641

Ordin, L., M.A. Hall, and J. I. Kindinger. "Oxidant-induced inhibition of enzymes involved in cell wall polysaccharide synthesis." (Presented at the American Medical Association, Air Pollution Medical Research Confernce, Denver, Colo., July 24, 1968.) Arch. Environ. Health, 18:623-626 (April, 1969).

Levels of peroxyacetyl nitrate or ozone which inhibit oat coleoptile section growth reversibly, inhibited formation of cellulose and of cell wall noncellulosic polysaccharides. After treatment of intact cells with PAN, phosphoglucomutase associated with subcellular particles was more severely inactivated than was soluble enzyme. A particulate cellulose synthetase from coleoptiles was inactiviated by either ozone or PAN treatment of oat celeoptiles. The results indicate that oxidant induced inhibition of one or more of these enzymes accounts for reduced polysaccharide synthesis.
Source: 1

#531
Ormrod, D. P., and N. O. Adedipe. "Protecting horticultural plants from atmospheric pollutants: A review." Hortsci., 9(2):108-111 (April 1974).

There is a need for both short and long term solutions to protect plants from air pollution damage; one of the long term solutions being breeding. Chemical protection is possible, apparently deactivating the oxidents at the leaf surface. Degree of protection is directly related to the concentration of the chemicals. Among these chemicals are fungicides, antioxidants, and growth regulators. The protection aspects of mineral nutrients are diverse, and several examples are reviewed. Plants grown under water stress conditions seem to be tolerant of atmospheric pollutants. Injury to plants is modified by several environmental factors such as temperature, light and humidity. Finally genetic tolerance of plants is reviewed.
Source: 2

#642
Ormrod, D.P., N.O. Adedipe, and G. Hofstra. "Ozone effects on growth of radish plants as influenced by nitrogen and phosphorus nutrition and by temperature." Plant Soil, 39(2):437-439 (Oct. 1973).

Raphanus sativus L. (radish) plants were grown in sand culture at two temperatures and fed with nutrient solutions containing relatively low or high levels of either nitrogen or phosphorus and were then exposed at the four-leaf stage to 25 pphm of ozone for 4 hr. Ozone treatments resulted in decreased dry weight of low and high-N plants at both temperatures and of low and high-P plants only at the lower temperature. Air pollutant growth reduction was not necessarily accentuated by luxuriant growth resulting from the high nutritional status. Responses to the nutrition of specific mineral nutrients appeared to depend on the modifying effect of temperature.
Source: 1

#1654
Oshima, R. J. "A viable system of biological indicators for monitoring air pollutants." (Presented at the International Congress of Plant Pathology, 2nd, Minneapolis, Minn., Paper 0996, Sept. 1973.) J. Air Pollution Control Assoc., 24(6):576-578 (June 1974).

An air pollution monitoring biological indicator (AMBI) system for ambient ozone was tested in the South Coast Air Basin of California during the 1972 fall growing season. The basic unit or AMBI station was an inexpensive, portable plant station which operated independently of power sources. Reliability of the unit was excellent, as only three instances of missing data were observed from 330 possibilities. The unit consisted of six indicator plants (pinto beans) with enough water for sustaining the plants in the field for 7 days. A photo-reference system of O_3 injury evaluation utilizing direct comparisons of injured leaves with reference photographs was successful in standarizing assessments of O_3 injury. Average weekly injury indices for field locations were correlated with average weekly O_3 dosages and were significant at the 0.01 level.
Source: 1

#1653
Oshima, R., O.C. Taylor, and E.A. Cardiff. "Severe air pollution episode in south coast basin." Calif. Agr., 28(2):12-13 (Feb 1974).

The photochemical air pollution episode that occurred between Nov. 8 and 11, 1973 in the south coast air basin of California, was unusual because the accompanying weather conditions and the resulting injury to vegetation did not fit into the pattern normally associated with attacks of ozone and peroxyacetyl nitrate (PAN). The injury to leafy vegetables was worse than usual, considering the concentration of phytotoxicants measured. Crop damage symptoms were generally of the type attributed to PAN, but the overall syndrome differed sufficiently to make it apparent that the incident was unique. Concentrations of oxidants differed markedly from one region to another. There was strong evidence that toxic levels of peroxypropinyl nitrate (PPN), a homologue of PAN, were present. In Orange County, where the most severe injury occurred, the smog contained a mixture of PAN, PPN, and O3. Elevated levels of toxicants persisted continuously for up to 40 hours. Thus, the PPN may have been the cause of the severe plant damage. Another possible explanation is that susceptibility of plant tissues may have been increased significantly by favorable weather conditions before and during the prolonged exposure. A new toxicant may have developed in the polluted atmosphere, perhaps in response to changes in primary pollutants being discharged.
Source: 1

#643
Oshina, T., R. Sugai, Y. Fujieda, T. Yanaka, and N. Shibuta. "Arumi seiren kojo shunhen ni okeru fukkabutsu ni yoru nosakubutsu osen." [Fluoride pollution on plants in area near an aluminum factory]. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 8(3):543 (Oct. 1973).

Fluoride accumulation in produce was examined in the area near an aluminum refining plant to obtain basic data for the health care of residents in the area. The relationship between F accumulation in produce with the distance and direction from the emission source, the species of produce, and the degree of air pollution were examined. Edible parts of turnip, eggplant, Chinese cabbage, potatoes, spinach, green scallions, cucumbers, and some of their leaves were checked at various distances and directions from the emission source; the area was divided by environmental quality classifications and the F content in the leaves and produce were examined. The measurements were taken by the ion electrode method after burning and distillation of the specimens. Fruit and root vegetables did not have high accumulation at any location, but the leaves had high F content even at a distance of 5 km, compared to the control area. When not taking the wind direction into consideration, the F content varied by the distance but lacked significance statistically. When studied by air quality classifications, the statistics showed a clear and significant relationship between F accumulation and the environment.
Source: 1

#847
Osterli, Victor P. "Effects of air pollutants on agriculture and forestry: Plants." In: Project Clean Air, California Univ., Berkeley, Task Force No. 5, Section 2, 23 p. (Sept 1, 1970).

The effects of air pollutants on plants are usually noted on the leaves because they are the site of gas exchange and photosynthesis. Pollutants often produce characteristic markings on a given plant species providing a means of pollutant identification. Severity of injury varies with pollutant, concentration, duration of exposure, and plant species. Specific effects are cited for sulfur dioxide, fluorides, photochemical oxidants, oxides of nitrogen, ethlene, pollutant combinations, and particulates. A recent estimate of air pollution damage to California crops is reported at $4.5 million annually. Increased attention must be given to the following research needs: improved accuracy in the assesment of economic losses to agriculture and forestry resulting from air pollution; the growth depression effect on plants due to long-term low-level exposure to ethylene, sulfur dioxide, fluoride, and oxides of nitrogen; the synergistic effect of combined sub-lethal concentrations of air pollutants on plants; the effects of air pollutants on biochemistry, metabolism, and anatomy of plants, the relative sensitivity of the various needle-leaf species; the quality of the forest air-environment, the impact of long-term oxidant exposure on growth; and more accurate methods for determining the extent and severity of smog damge.
Source: 1

#644
Ota, Y., H. Nakamura, and S. Shibukawa. "Saitama-kenka no taiki osen ni yoru shokubutsu higai ni tsuite-toku ni PAN ni yoru to omowareru higai." (An investigation of injury to plants from PAN-like air pollution in Saitama Prefecture). Text in Japanese. (Presented at the Japan.Society of Air Pollution, Annual Meeting, 14th, Fukkushima, Japan, Paper 271, Nov. 6-8, 1973.) Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 8(3):545 (Oct. 1973).

The damages of Saita prefecture's agricultural produce by photochemical smogs this year show a clearly different type from the previously known ozone damages. Several lettuce farms, a green vegetable patch, and one spinach patch had this type of damage, while adjacent farms showed damages from orainary O_3, or no damage at all. Damage appears as shiny spots on the backs of the leaves; in light cases, thecolor is silvery, and in more serious cases the color is golden or brown, and the spots are irregularly shaped and appear between veins. In more progressed cases, the shiny spots turn a brown-copper color and some of them develop into necrosis. In this case, damages may extend to the upper surfaces. These damages may have been caused by peroxyacetyl nitrate.
Source: 1

#1655
Ota, Yasuo, Saburo Shibukawa, and Renpei Kamino. "Saitama-ken ni okeru kokogaku sumogga ni yoru saki motsu higai no hassei jokyo to sushu yakuzai no koka tsuite." (Crop damage by air pollution in Saitama prefecture and chemical preventives). Japan Society of Air Pollution, Proc. Symp. Japan Soc, Air Pollut., 13th, p. 25, Paper 185 (Nov. 7-9, 1972).

Photochemical smog damage to scallions were observed in southeastern Saitama in the areas adjacent to Tokyo. The preventive effects of ascorbic acid, glutathyon, and alsolbin acid were examined by spraying 10 ppm solutions on the scallions. The effect of a 0.5% solution of thiophanate methyl was also examined by treating the soil with the solution. The photochemical smog damage in its initial stage showed an odd waxy texture on the scallion leaves; when the damage advanced, the tips began to wither, and chlorosis and curling began to appear. The damage could be cured in the initial stage. The chlorosis and the curling of leaves occurred in the same direction. The heaviest damage occurred in the SW, followed by thke SW. As a damage preventive, thiophanic methyl had the most notable effect. Ascorbic acid, glutathione and alsolbin acid also showed a slight effect compared to the damage in the control area.
Source: 1

#966
Owers, M. J., and A. W. Powell. "Deposition velocity of SO_2 on land and water surfaces using a ^{35}S tracer method." Atmos. Environ., 8(1):63-67 (1974).

The absorption of sulphur dioxide onto land and water surfaces has been studied by means of field trials using SO_2 labelled with ^{35}S. Several measurements of the depositon velocity of sulphur dioxide have been made on land and water surfaces and the effect of a hedgerow has also been investigated. From these results and other measurements of deposition velocity reported in the literature, it is concluded that the average deposition velocity for SO_2 over the British Isles is likely to be about 0-8 cms^{-1} (referred to concentrations measured 20 cm above the surface).
Source: 5, 6

#1656
Pack, M.R. "Effects of hydrogen fluoride on production and food reserve content of bean seed." Washington State Univ., Pullman, Air Pollution Research Section, 7 p. (1969).

Mature seeds of Tendergreen bean plants, grown under continuous exposure to hydrogen fluoride at 10.5 micrograms F/cu m, had a shrivelled appearance and lower starch content than seeds of control plants. Two more experiments were conducted in which bean plants were exposed con-

tinuously to HF at 21 and 9.1 micrograms F/cu m. These seeds also matured more slowly in the HF treatment and tended to be shrivelled and distorted. They had a faded blue-black color rather than the glossy black of the control plants. These differences were most pronounced in the higher HF treatment. The seed of the HF treated plants also had a lower starch content, suggesting that the fluoride interfered with starch synthesis. The HF treatments had no apparent effects on the reducing sugars, total sugars, water soluble polysaccarides, protien, or ether extract of the bean seed. Seedlings grown from the HF affected seed showed delayed emergence and less vigorous growth than control seedlings. The cordate primary leaves were abnormally small and distorted.
Source: 1

#577
Pack, Merrill R. "Effects of hydrogen fluoride on bean reproduction." Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo. 70-134 (June 14-18, 1970).

Tendergreen bean plants were grown from planting to seed maturity under continuous exposure to hydrogen fluoride in fairly uniform concentrations averaging 10.5, 9.1, and 2.1 micrograms F/cu m. Progeny of these plants and of comparable control plants were grown in a clean atmosphere to determine if subsequent generations were affected by HF treatment of the parents. The F-1 generation progeny of the JF treated plants were less vigorous than control plant progeny, as showed by later emergence, smaller primary leaves, and slower stem growth. This probably was a consequence of the lower stand content of the seed of the HF treated plants.
Source: 1

#578
Pack, Merrill R. "Response of strawberry fruiting hydrogen fluoride fumigation." Air Pollution Control Association, Annual Meeting, 64th, Atlantic City, N.J. 71-102 (June 27-July 2, 1971).

Strawberry plants were grown throughout flowering and fruiting under continuous, long-term exposure to hydrogen fluoride gas at fairly uniform concentrations averaging 0.55, 2.0, and 10.4 micrograms/cu m. At 0.55 micrograms fluoride/cu m, there was a small but significant increase in furit deformations predominantly at the apical end of the fruit, which was associated with lack of development of some seeds and the adjacent receptacle tissue. In the higher HF treatments, deformities were proportionately more prevalent and severe. At 2.0 micrograms F/cu m and higher, the average fruit weights were also significantly lower than in the control atmosphere; and at 5.0 and 10.4 micrograms F/cu m, the proportion of the flow that developed into fruit was smaller. None of the HF treatments significantly influenced the number of flowers produced. There were no fluoride injury symptoms on foliage at 0.55 micrograms F/cu m and only very mild, uncertain symptoms at 2.0 micrograms F/cu m. Therefore, the effects of HF on strawberry fruiting seemed to be independent of visible injury to the foliage and to result from inhibition of seed development.
Source: 1

#267
Pady, S.M., C.L. Kramer, and R. Clary. "Periodicity in aeciospore release in Gymnosporangium juniperi-virginianae." Phytopathology, 58(3):329-331 (March 1968).

Data are presented on the release of aeciospores from Gymnosporangium juniperi-virginianae, the cause of cedar-apple rust. Four Kramer-Collins spore samplers were set up, and samples were taken three times during the hour for a total of 10 min. The same leaf was used as long as spores were being produced, usually 6 to 8 days. Aeciospore release was diurnal, with a major peak between 6 and 8 am and on some days, a minor peak 12 hr later. Spore release was correlated with declining relative humidity, and high relative humidity completely prevented such release. Highly hygroscopic peridial cells were the mechanisms that control the release of the aeciospores.
Source: 1

#1657
Page, A. L., and T. J. Ganhe. "Accumulations of lead in soils for regions of high and low motor vehicle traffic density." Environ Sci. Technol., 4(2): 140-142 (February 1970).

Accumulation of lead in soils over a period of approximately 40 years was compared for areas of high and low motor vehicle traffic densities. Where motor vehicle traffic density was less than 80 motor vehicles/sq mi, no lead accumulation was observed, but where the motor vehicle traffic density was greater than 580 motor vehicles/sq mi, the concentration of lead in the surface 2.5 cm of soil increased by a factor of two to three times. Despite these percentage increased, the amount of lead found in the surface soil did not exceed 52 ppm, a level which is common to many soils from areas of low traffic density and not subjected to atmospheric or industrial lead contaminations. The amount is considerably below levels which may cause toxicities to economic plants.
Source: 1

#382
Page, A.L., T.J. Ganje, and M.S. Joshi. "Lead quantities in plants, soil, and air near some major highways in Southern California." Hilgardia, 41(1):1-31 (July 1971).

The lead content of 27 varieties of consumer crops and plants growing near some major southern California highways were colorimetrically ascertained. Amounts of Pb were also recorded for surface and subsurface soils and in suspended air particulates at or near the locations where the plant samples were obtained. Exposed tissues of plants grown very close to highways contained more Pb than similar tissues of plants grown some distance from the highways. This effect was most apparent at distances less than about 150 meters from the highway. Exposed tissues with smooth surfaces accumulated

more lead than tissues with rough, hairy surfaces. The direction of the prevailing wind also significantly affected Pb concentrations in plants near highways; without exception, Pb in plants on the leeward side of the road exceeded that in plants on the windward side. A motor vehicle density of 35,000 vehicles/day also resulted in substantial Pb accumulations in plants. In soils and suspended particulates, lead concentrations were influenced by distance from highway and direction of prevailing winds. These results all demonstrate that the lead accumulations were caused primarily by aerial deposition and not -- at least to any great extent -- by absorption by the plant from Pb-contaminated soil.
Source: 1

#1658
Pahlich, E., H.-J. Jaeger, and L. Steubing. "Beeinflussing der Aktivitaeten von Glutamatdehydrogenase und Glutaninsynthetase aus Erbsenkeimlingen durch SO2." (The effect of SO2 on the activities of glutamate dehydrogenase and glutamine synthetase from pea seedlings). Angew. Botan., 46:183-197 (1972).

The effect of sulfur dioxide on the metabolism of glutamate dehydrogenase and glutamine synthetase in pea seedlings was investigated. The glutamate dehydrogenase reacted in a typical fashion: the NADH reaction was activated with an accelerated synthesis of L-glutamic acid and the conversion rate of the NAD+ reaction decreased, reducing the decomposition of L-glutamic acid. The enzyme glutamine synthetase only slightly increased in activity.
Source: 1

#848
Palm, Einar W. "What air pollution does to your plants." Crop Soils Mag., 24(3):14-17 (Jan 1971).

Air pollution causes an estimated $500 million in plant losses each year. The invisible chemicals, such as sulfur dioxide, hydrogen fluoride, ozone, nitrogen dioxide, ethylene, and peroxyactyl nitrates in smog are much more injurious to plants than the black emission from smokestacks, diesel trucks, and busses. Plants injured by air pollution will be more susceptible to parasitic diseases, while diagnosis is often complicated because two or more chemicals may work together to increase the injury. Some pollutants, such as ozone, will react differently, on different species of even varieties of the same plant species. Sulfur dioxide, produced in the smoke stacks of industrial plants, can be a double threat. The chemical itself is damaging to plants, and it may also combine with moisture to form droplets of sulfuric acid which can injure plant tissues. Certain indicator plants can be used to help determine what pollutants are the cause of plant injury. Finding a plant variety or substitute crop that is less susceptible to foul air is one step that can be taken, or high-value crops might be sprayed with pollution-reducing materials such as ozoban and ascorbic acid. Plant breeding in the future will be directed toward the identification, selection, and production of plants which can actually filter pollutants out of the air. However, government, industry, and our universities must work together to reduce the toxic materials in our air. Sources, plant response, and symptoms are presented tabularly for sulfur dioxide, hydrogen fluoride, hydrogen chloride, nitrogen dioxide, ozone, peroxyacetyl nitrate, ethylene, and particulate matter.
Source: 1

#1661

Paluch, Jan. "Die Moeglichkeiten der Anwendung von Pflanzentesten zur Beurteilung des Luftverunreinigungsgrades." (The application of plant tests in the assessment of the degree of air pollution). Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p. 219-234 (Sept 9-14, 1968).

Tests of germination and root formation during the initial developmental stage of plants were used to assess the degree of noxiousness of precipitation which in turn reflects the degree of air pollution. The germination power of seed grains of Pisum sativum, Brassica oleracea, Papaver somniferum, and Zea mays was tested (percentage of germinating seed kernels, of burst, and of swollen kernels) and their root lengths measured. Studied was the effect of spring and of summer precipitation at Giwice, Zabrze, Chorzow, Sosnoviec and Katowice in the Upper Silesian industrial basin. The tests were performed in sand-filled earthenware planters placed on Petri dishes filled with the precipitation samples. Twenty grains were planted in each planter and measured eight days later. Comparative tests were made with precipitation from other, relatively low-pollution areas. The precipitation from Chorzow (with the highest evaporation residue) inhibited the development of roots and germinating seeds by 50% in pea, poppy, and maize seeds and by 15% in oat and clover seeds. Some of the samples had a growth-promoting effect which is still unexplained. Plant tests are potentially useful as indicators of maximal permissable levels of pollutants, but further research is needed.
Source: 1

#37

Paluch, J. "Europaeischer Erfahrungsaustausch ueber Haldenbegruenung in Essen." (European conference on greening mining dumps in Essen - October 3-5, 1972). Forstarchiv, 1:12-14 (January 1973).

"Dumps in the Ruhr Valley and Their Integration into the Environment" was the topic of the conference held in Essen, October, 1972. The dumps are a by-product of underground coal mining. The meeting included reports on experiences with dumps in other European countries and an inspection of dumps in the Ruhr Valley. The shapes and the material contained in the dumps were analyzed and possibilities for planting on the dumps were discussed.
Source: 6

#1660
Paluch, J. and S. Karweta. "Die Akkumulierung von Zink und Blei im Boden und in Pflanzen." [Accumulation of zinc and of lead in the soil and in plants]. Polska Akademia Nauk. Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego. Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th. Katowice, Poland. p. 127-138 (Sept 9-14, 1968).

The accumulation of zinc and of lead in soil and plants was studied in a rural wooded area of Poland following the construction of a zinc, lead, and cadmium ore processing plant. Before establishment of the plant, the soil of the area contained between 15 and 1600 mg Zn/kg and between 40 and 3600 mg Pb/kg, indicating lead and zinc-bearing outcroppings among the samples collected at 22 randomly selected points. Absorbable zinc and lead compounds fluctuated between trace quantities and 31.30 mg Pb/kg and 22.43 mg Zn/kg, depending on soil acidity. In alkaline soils these amounts were almost zero. Following operation of the plant for a year (and consequent dust emission) the Pb and Zn soil content increased noticeably, especially in soils with initially low Zn and Pb levels where the increase amounted to several hundred percent. Generally Pb and Zn content in conifers in the polluted area increased, with the Zn level increasing more than the Pb. A clear cut correlation was found between available soil Pb content and assimilation by plants; the correlation was less obvious for Zn. Both Zn and Pb levels in plants manifested great differences during the vegetation period. Zn content in pine needles increased steadily over a three-year observation period while no difference in the Pb content was found in two and three-year old needles. Although no deleterious effects were noted in annual or in perennial plants, these are expected to occur eventually.
Source: 1

#1659
Paluch, J., and S. Karweta. "Zinc and lead immission in the surroundings of a metallurgical combine and its effect of plants and soil." Air Conserv. (English translation from Polish of: Ochrona Powietrza), 4(6)(20):5-14 (1970).

Results of a 5-year study involving the measurement of zinc and lead dust emissions in the surroundings of zinc and lead-producing metallurgical plants and the accumulation of the metals in nearby soil and vegetation are reported. The data indicate the zinc and lead in dusts, expressed as metal precipitate per surface and time unit, have been continually increasing since the start-up of the various plants in the metallurgical combine. Continual increases in the content of total zinc and lead in the surface layer of soil were found for the period 1966-1969. Effects of the process have so far been limited to the top layer. Fallout of zinc and lead oxides as well as calcium oxide has been found to result in alkalization of the soil; at one site the pH changed from 3.3 to 6.1 over the five year period. Accumulation of the metals in plants has proceeded much more intensely than in soil, and all plants in the region have increased contents of zinc and lead. Lead has increased more intensively than zinc to levels several dozens of times greater than those of 1966. No apparent decrease in yields of plants has yet been noticed.
Source: 1

#645
Paluch, Jan and Irina Schalenkowa. "Die Luftverunreinigung durch Fluor in Polen und ihre toxische Wirkung auf Menschen, Tiere und Pflanzen." (Air pollution by fluorine in Poland and its toxic effect on humans, animals and plants). Wiss. Z. Humboldt Univ. Berlin Math. Naturw. Reihe, 19(5):489-492 (1970).

The major sources of the emission of fluoride compounds to the atmosphere are aluminum phosphorous fertilizer manufacturing plants. In Poland, the superphosphate industry alone produces a fluorine emission of some 4000 to 5000 tons annually, the aluminum industry some 2000 tons. Fluorine has a toxic effect on plants and animals, generally in an area within a radius of 1.5 to 3 km. External symptoms on plants are necrosis of leaf borders which can lead to destruction of their metabolic system and eventual plant death. Some plants, like cabbage, are more resistant than others in this respect. Peach leaves, for instance, are extremely sensitive to fluorine concentrations. The plants in general absorb the fluorine through their leaves and store it; such afflicted plants represent a danger to animals and human beings if taken in as food. The biological and clinical symptoms of fluorosis are due to changes in the calcium and iodine balance in the human of animal organism. Typical externally noticeable symptoms in animals are deformations of long bones, ribs, and joints, followed by lameness. Young animals show disturbances in growth and changes on their teeth. In humans, the most well known effects are those brought about by fluorine in drinking water. Acute fluorine poisoning can be caused by intake of food which has been contaminated by fluorine compounds. These occur in some insecticides and in some plant sprays.
Source: 1

#1007
Parbery, D. G. "The effects of common air pollutants on plants." Clean Air 8(2):44-47 (May 1974).

The toxicity and effects of common air pollutants on plants are reviewed. Threshold concentrations at which damage is observed are these: sulfur dioxide, 0.15 ppm for the more sensitive species; ozone 5-12 pphm for the more sensitive plants; and peroxyacetyl nitrate (PAN), 1 pphm to injure most plants. Fluorides do not cause injury to plants until a certain threshold value is reached, but their effects are accumulative. Damage to SO_2 varies considerably according to the species of plant involved. Ozone affects plants by reducing the photosynthetic rate, thereby lowering the production potential; by interfering with the respiration rate; and by interfering with growth and reproduction. The effects of PAN are similar to O_3 except it is more deadly. Considerable deposits of lead occur on vegetation including vegetables, growing beside busy roads. Lead is accumulative and the constant intake of low levels of Pb could have grave consequences, not to the plants, but to those eating them.
Source: 2

#579

Parish, S.B. "The effect of cement dust on citrus trees." Plant World, 13(12):288-291 (Dec 1910).

Some years ago a small cement mill was built at the northern foot of Slover Mountain in the San Bernardino Valley, California, and it has grown, with the increasing demand for its product, to be an establishment of considerable size; and now a still larger mill has been built on the southern side of the mountain. The amount of dust deposited in two orange orchards near the mills was ascertained during one week by exposing a number of glass plates, coated with vaseline and placed horizontally on supports about three feet high. At fixed intervals, the dust thus collected was removed, freed from the vaseline, dried and accurately weighed. The annual deposit of dust per acre in these two orchards was 2.39 and 3.18 tons. Cement dust differs from other dust in that by absorbing dew and the hygroscopic moisture of the atmosphere, it forms on the leaf surface a hard, opaque, pellicle which is not removed by rain, and, indeed, not removed without difficulty by hand. Careful microscopic examinations have demonstrated that a leaf whose surface was cement coated produced but one fourth as many starch granules as an equal area of clean leaf.
Source: 1

#1149

Pasquill, F. "The estimation of the dispersion of windborne material." Meteorol Mag., 90(1063):33-49 (1961).

The theoretical estimation of the concentrations arising from sources of gaseous or finely divided particulate material has for long been based on treatments of atmospheric diffusion developed by Sir Graham Sutton, and subsequently expressed in the well known formulae for surface and elevated sources (see Micrometeorology, p. 290[1]). These formulae are reliable for specifying the average distribution, over a few hundred metres downwind of a source operating for a few minutes on level unobstructed terrain, with a steady wind direction and neutral conditions of atmospheric stability. Extension to other circumstances has depended on empirical and often speculative adjustments of the diffusion parameters.

During the last few years, further investigations at the Chemical Defence Experimental Establishment, Porton, have shown that a fairly rational allowance can now be made for the effects of much of the wide variation in atmospheric turbulence which occurs in reality. This progress includes some extension to longer distances of travel. Although many aspects of the problem require further attention, these recent developments, supported also by experimental studies in the U.S.A., form a basis for a tentative system of estimating diffusion in a wide range of meteorological conditions and over distances up to about 100 kilometres.

The purpose of this article is to review the recent background of theoretical and experimental results, and to give details of the proposed system of calculating the distribution of concentration downwind of a source. These details are set out in two appendixes, the first giving complete instructions for carrying out the calculations, the second presenting an example.
Source: 5

#731
Pasternak, K. "The influence of the polluton of a zinc plant at Miasteczko-Slaskie on the content of microelements in the environment of surface waters." Acta Hydrobiol, 16(3/4):273-297 (1974).

The level of the concentration of microelements and their accumulation and distribution were determined in the water and sediments of rivers, streams, and reservoirs in the region of zinc and lead smelting works. It was found that already in the first period of the activity of such industries the state of purity of neighbouring surface waters is affected not only by the release of wastes but also by the pollution of the air. The occurrence of heavy metals in the waters and sediments was considered against the background of their basic properties and of the general pollution situation of the region. The release of metallurgical waste waters brings about a very great increase in the amount of Zn, Cd, and Pb in the main river of the investigated territory. An exceptionally high content of cadmium occurs in the water of this river, which among other factors decreases the class of purity of this river. In the investigated water system the degree of distribution of metals, especially of Zn, is very high. The reservoirs on this river favour the self-purification of the water from the metals.
Source: 2

#1735
Paukert, Jindrich. "Mozne vyuziti hliz bramboru (solanum tuberosum) jako indikatora nekterych prvku pritomnych v prumyslovych imisich." (Possible use of potato tubers (Solanum teberosum) for the indication of some elements present in industrial immissions). TERPLAN-Statni ustav pro uzemni planovani. Ustav Krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiny, Sbornik Z Mezinarodni Konference, Prague, Czechoslavakia, 48-52 (1971).

Potato tuber pulp samples obtained from an industrially-contaminated locality contained molybdenum in 100% of the cases as compared to 5% occurrence for those from control plots; lead was found in 55% as compared to 15% for controls; chromium was found in 30% of the samples as compared to 5% for controls; and tin was observed in 10% as compared to 0% for controls. Molybdenum, whose occurrence rate fluctuated to a considerable degree in the pulp samples, was represented by equal quantities in all peel samples. Soil samples from both areas showed an absence of molybdenum, whereas the industrial emissions were positive for the metal. Lead was present in emissions in quantities larger by one order than for soils and tubers. Chromium was found in emissions, soil, and tuber samples. Tin was found in the emissions and the contaminated tubers.
Source: 1

#1587
Payrissat, M. "The cycle of sulphur dioxide in the atmosphere." Eurospectra, 13(1):16-22 (March 1974).

The sulfur dioxide cycle in the atmosphere is reviewed. Natural sources of SO2 are volcanoes, forest fires, and oxidation of hydrogen sulfide produced by the breakdown of living matter. The remaining 95% of the SO2 in the atmosphere is anthropogenic, most of it caused by coal burning, the burning and refining of heavy petroluum products, and the treatment of pyrites in foundries. As SO2 diffuses throughout the atmosphere it becomes a global pollutant. Since SO2 is a reducing agent, it tends to oxidize in the atmosphere to sulfate and sulfite. The transformation is promoted by a number of factors such as photochemical interactions with ozone and sunlight. Rain can be contaminated with the sulfur compounds and become acidic. As a result of man-made pollution, the amount of sulfur processed by nature has increased by half. The sulfur compounds are absorbed in soil and vegetation and enter the oceans through the rain. Plants and soil bacteria metabolize the SO2 and sulfates they absorb, converting them to H2S which is emitted into the atmosphere to be reoxidized photochemically into SO2 in the presence of ozone. Part of the soil enters the oceans. The lifespan of SO2 depends on meteorological factors involved in the chemical conversion of SO2 into sulfates and by absorption in the surface of the soil. Laboratory methods to measure absorption of SO2 by soil include the aerodynamic, West and Gaeke, hydrogen peroxide, and electroconductivity methods. Mathematical formulas are given to determine the SO2 deposition on standard European soils.
Source: 1

#1254
Payrissat, M. and S. Beilke. "Laboratory measurement of the uptake of sulphur dioxide by different soils." Atmos. Environ., 9(2):211-217 (Feb. 1975).

The influence of some soil parameters on the uptake of sulfur dioxide by different European soils was investigated in a closed chamber. An increase of soil pH from 4.5-7.6 corresponded to a 10-fold increase in soil resistance to SO2 transfer under constant transfer conditions at a relative humidity of 40-50%. At constant pH the soil resistance decreased with increasing relative humidity. The soil resistance to SO2 uptake was most sensitive to relative humidity at low soil pH. The influence of prior SO2 contamination on further SO2 uptake by the soils was small compared to that of pH and relative humidity.
Source: 1

#349
Pdzorov, N.V. "The drainage of temporarily swamped soils in relation to pine plantings growing under conditions of industrial air pollution." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Vol III. The Susceptibility of Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union. M.Y. Nuttonson (ed.), Silver Springs, Md., American Institute of Crop Ecology, p.33-38 (1970). Also: Izv. Vyssh. Ucheb. Zaved. Les. Zh., 2:27-31 (1967).

When pine stands in a swamped forest area within a zone of intensive air pollution were drained, the number of dead trees dropped sharply. Three years after the drainage, experimental plots were laid out at 0-20, 40-60, and 60-100 meters from the drainage ditch to study the effects of drainage on soil with excess moisture. Sulfur accumulation in pine needles and number of cones without seeds increased and the number of dead trees, weight of needles and cones, and lifespan of needles decreased with distance from the ditch. The results demonstrate that the effect of polluting gases of the same concentration and duration on pines varies according to soil moisture content.
Source: 1

#1931
Pearson, L.C. "Air pollution and lichen physiology: Progress and problems." In: Air Pollution and Lichens, B.W. Ferry, M.S. Baddeley, and D.L. Hawksworth (eds.), Toronto Univ. Press, Toronto, 225-237 (Chapt. 11) (1973).

The effects of sulfur dioxide pollution on lichens were investigated. The rate of respiration in desert lichens increased by exposure to SO2 fumes. The amino acid composition of the proteins of L. melanophthalma were measured using paper chromatography. The R subscript F values of both cysteine and cystine decreased in direct proportion to the degree of pollution. The correlation between air pollution, as determined by the distance from the source, and change in the amino acids was high and statistically significant. Sulfur dioxide and carbon monoxide cause similar morphological symptoms in lichens. There were no changes in the amino acids as a result of CO fumigation.
Source: 1

#849
Pearson, Lorentz and Erik Skye. "Air pollution affects pattern of photosynthesis in Parmelia sulcata, a corticolous lichen." Science, 148:1600-1602 (June 18, 1965).

Lichen disks kept in flasks contaminated with sulfur dioxide showed morphologic and photosynthetic abnormalities similar to those of lichens from an industrial center in Sweden, but lichens dried out for four and one-half to six months showed neither. Thallus lobes of the lichens collected from the air-polluted sites, especially from Slottsbacken near the center of Uppsala, were pale in color, frequently discolored pink, and neither as thick nor as succulent as the lobes of the normal lichens. As the light intensity was increased from 0 to 80 volts, apparent photosynthesis increased from -4 to -2 ml of 02 per hr in the lichen disks rated 3, 4, of 5, remained about the same in the disks rated 2, and decreased in the poorest disk, rated 1. With heavy contamination (1,5,or 10% SO2) the lobes of artificially exposed lichens became very pale in color, sometimes showed a pink discoloration, appeared dried, and carried out net respiration at all light intensities. Thus, some kinds of lichens may be absent from city environments because of atmospheric pollutants which destroy chlorophyll.
Source: 1

#850
Peirce, George J. "An effect of cement dust on orange trees." Plant World, 13(12):283-288 (Dec 1910).

In the San Bernardino Valley in Southern California, the principal occupation of the people is the growing of citrus fruits, but with the very rapid increase in the use of cement, cement manufacturing plants have been established and operated in this valley, as well as elsewhere. Particles of dust falling on the smooth and glossy upper surface of the shiny leaves of these citrus fruit trees, accumulate after a time into a layer of considerable thickness; these particles cohere and set in dew or fog or gentle rain, adhering to the surface of the leaf to rather a surprising degree. Such an opaque crust interposed as a screen over the upper surface of the leaf cannot fail to reduce the amount of light entering the leaf. If the manufacture of non-nitrogenous food is interfered with, all the other activities of the plant are correspondingly affected. This decrease in the amount of food made daily in the leaves of orange and lemon and grapefruit has resulted in a decreased yield, as well as in a decreased growth of the trees.
Source: 1

#50
Pell, E.J., A. Rhoads, E. Brennan. "Assessment of symptomatic (direct) response of woody vegetation to air contaminants," IV part of the symposium Air Pollution and Woody Vegetation in the Metropolitan Northeast. A Problem Analysis prepared by the Consortium for Environmental Forest Studies.

Direct damage to natural trees (as opposed to agricultural sp.) by air pollutants was observed in field surveys in a metropolitan area. Affected trees showed varying degrees of foliar necrosis, dieback and complete mortality. To provide a basis for the diagnois of symptoms observed in the field controlled fumigations were conducted. These symptoms are described. The mechanisms of abnormal physiology resulting from the air pollution is discussed.
Source: 1

#1662
Pell, Eva Lindauer. "The adenosine triphosphate to total adenylate status of ozonated pinto bean foliage and its relation to photosynthesis and respiration." Rutgers-The State Univ., New Brunswick, N.J., Dept. of Biology, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 114 p. (Jan 1972).

Pinto bean plants were exposed to 0.25-0.30 ppm ozone for 3 hr. Immediately after ozonation when visible symptoms were not yet apparent, primary leaves of control and treated bean leaves were harvested for determination of ATP, total adenylate content, and respiration and photosynthesis rates. A repeatable, accurate method of ATP extraction was developed for use with pinto bean foliage. Adenosine diphosphate (ADP) and adenosine monophosphate (AMP) were converted to ATP with ATP creatine phosphotransferse, and total adenine nucleotides were then

analyzed by the luciferin-luciferase technique. Oxygen uptake and evolution were reported in microliters oxygen per hour per milligram dry weight. In three out of four experiments there were no symptoms of ozone toxicity immediately after exposure but symptoms did develop after 24 hr. The ozonated bean leaf tissue that was harvested immediately had significantly higher concentrations of ATP and total adenylates than did control tissue, and the ratios of ATP to total adenylate content remained unchanged. In two out of three of these experiments the respiration rates of ozonated leaves remained unchanged, but in the third, it increased significantly. Photosynthesis of treated pinto bean leaves decreased significantly in all experiments. In the fourth experiment visible symptoms did not develop even after 72 hours. In this case ATP, total adenylate content, and respiration rates of ozonated tissue remained the same as that of the control, whereas photosynthesis decreased. A kinetic study was conducted to determine whether there was any direct relationship between ozone-induced changes in photosynthesis, respiration, and adenine nucleotides and whether these changes persisted as the symptoms developed. The ozone toxicity symptoms began to develop within 21 hr, becomming prominent in all samples within 72 hr. The ATP content of ozonated pinto bean leaves was significantly higher than that of the controls at 0.6 and 72 hr but not at 21 hr after ozonation. The increase in total adenylates in pinto bean leaves observed immediately after ozonation persisted through the 21 hour period. The ratio of ATP to total adenylate content was not affected by exposure to ozone. Respiration increased significantly in ozonated pinto bean leaves and the increase became greater as the symptom developed. The decrease in photosynthesis observed immediately after ozonation persisted for 6 hr, but photosynthesis returned to normal by 21 hr.
Source: 1

#1663
Pellissier, Marc. "La pollution atmospherique et ses effets sur la vegetation." (Atmospheric pollution and its effects on vegetation). Ministere de la Protection de la Nature et de l Environnement (Quebec) and Quebec Univ., Trois-Riveres (Quebec), Joint Pub., 51 p. (1972).

The effect of air pollution on vegetation and the air quality in the Canadian industrial regions of Shawingan, Grand-Mere, Trois-Riveres, and Cap-de-la-Madeleine were investigated. The major emissions in the areas were trace to their sources, and the industrial processes and controls were examined. Pollutants of greatest interest due to their toxic effects on vegetation were sulfur dioxide, fluorine and chlorine compounds, particulates, and hydrogen fluoride. The general effects of the pollutants on vegetation were reviewed, and damages to vegetation characteristic of each region were studied with respect to plants affected sensitivity ratings, and symptoms of damage. The Shawinigan area was the most affected by air pollution, followed by Cap-de-la-Madeleine, Troil-Riveres, and Grand-Mere. The major symptoms, detected in various degrees on the leaves and needles of trees, included necrosis, defoliation, burns, chlorosis, and spotting.
Source: 1

#1136
Pelz, E. "Untersuchungen über die individuelle Rauchhärte von Fichten." (Pine tree resistence to smoke damage). Wiss. Z. Techn. Univers. Dresden (Herausgeber: Der Rektor), 11(3):595-600 (1962).

The individual resistance of pine trees to smoke was determined based on phenotypic characteristics found in locally differing test areas which were exposed to varying amounts of smoke. A definite statistical correlation was found: the number of dead pines increased and the number of phenotypically smoke resistant test trees decreased - with increased smoke emissions, older trees, worse location and robustness of the pines. Both groups of different phenotypical smoke resistant trees differed in: medium seasonal radial growth, various external characteristics, and seasonal developments of physiological processes in the needles. The turbidity test after Härtel and the analysis of leaf pigments were the same for smoke free or smoke affected stands. The results show that the two groups of trees differ in physiological processes in the needles - which is probably the reason for differing smoke resistance. This knowledge can be used in the care of smoke affected pine stands and in the selection of smoke resistant trees for forest cultivations impacted by smoke.
Source: 6

#1664
Pelz, E. "Die Bestimmung des Grades der Rauchschaedigung in Fichtenbestaenden." (Determination of smoke damage degree in spruce stands). Soz. Forstwirtsch., 16(6):239-242 (1966).

With regard to smoke damage, persons concerned with forest management are primarily interested in having a method of their disposal with which to record stages of damaged based on largely standardized parameters. The method must be applicable to large areas and feasible for practicing foresters in the field who may not be specially trained in the field of smoke damage. Different methods used for determining the extent of damage of an area and graduations of damage are reviewed. An attempt at classifying degrees of damage in the state forest district of Freiberg is described, as well as experiences in the Tharandt district. The principal basis for a smoke damage evaluation method are those features which are not influenced by the seasonal development of plant life, namely members of severely damaged trees in a stand, appearance of symptoms of dying, and effects on stand structure.
Source: 1

#646
Pelz, Eberhart. "Der Wald als Bioindikator einer Landschaftdereriorisation durch Luftverunreinigung." (Forest as a bioindicator of air pollution-generated landscape deterioration). TERPLAN-Statni ustav pro uzemni planovani, Ustav krajinne ecologie CSAV, Bioindikatory Deteriorizace Krajiny, Sbornik Mezinarodni Konference, Prague, Czechoslovakia, 111-118 (1971).

Possibilities and methods of the use of forests as bioindicators of air pollution are discussed. Due to their large extension and longevity, forests, especially coniferous, are especially suitable for indicating air pollution in chronic and acute exposures. Industrial emissions cause rarefaction of species in soil, phytocenoses, and zoocenoses. The color, size, shape, density, anatomic and biochemical features of the needles, and the rate of growth of the individual tree can be used as criteria for the determination of the effect of air pollutants. Aerial color photographs of forests permit the delimitation of damage zones on the basis of differences of color in an objective manner.
Source: 1

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#647
Pelz, Eberhart. "Untersuchungen in Richtenbestaenden als Bioindikatoren fuer Luftverunreinigungen." (Studies on pines as bioindicators of air pollution). TERPLAN-Statni ustav pro uzemni planovani, Ustav krajinne ckologie CSAV, Bioindikatory Deteriorizace Krajiny, Sbornik Z Mezinarodni Konference, Prague, Czechoslavakia, 119-125 (Sept 1971).

Factors modifying the degree of smoke damage in pine forests were studied. Close interrelationships between the degree of damage, the age and site of the trees, weather conditions, and the pollution levels, were established. Trees living under labile conditions were most susceptible to air pollution. A reduction in the normal number of needles on trees with increasing levels of pollution was observed. Reduction in the normal number of needles on older trees was seen with low levels of air pollution, while high pollution levels resulted in needle reduction in all age classes of evergreens.
Source: 1

#851
Pelz, Eberhart, Horst Beyer, and Gerhard Bleyer. "Untersuchungen zur Diagnose und Wirkung von Rauchschadden in der Umgebung einer Bleihuette." (The diagnosis and effects of smoke damage in the vicinity of a lead smeltery). Wiss. Z. Tech. Univ. Dresden, 12(1):209-216 (1963).

The effects of extreme smoke emission from a lead smelting plant situated 340 m above sea level with a median yearly temperature of 7.7C and an annual precipitation of 868 mm on the surrounding woods were studied by analyzing the air using the Liesegang method, by conimetric determination of dust emission, by soil analysis for the presence of arsenic, and by Haertel's turbidity test. A positive, statistically significant correlation coefficient (0.83) was found to exist between the number of dust particles per liter of air and the median sulfur content of air samples from nine locations. The damage to vegetation was greatest where continuous SO2 emission was compounded by considerable As soil concentrations. Deciduous trees were generally more resistant than conifers. Birches were most resistant of all tree varieties. Severe damage was confined to a distance of 1 km from the source.
Source: 1

#852

Pelz, Eberhart and Jan Materna. "Beitraege zum Problem der individuellen Rauchhaerte von Fichte." (Studies of the problem of individual smoke resistance of spruces). Arch. Forstw., 13(2):177-210 (1964).

A study of damage to spruce trees due to air pollution is presented. About 900 trees were studied and grouped into resistance classes according to their phenotypical smoke resistance. Relationships between age, quality of growth site, degree of needle coverage, and weather conditions were determined. Trees in different classes exhibited different growth patterns, due to different physiological activities of the trees. Trees sensitive to damage had higher concentrations of sulfur as their needles, due to a higher degree of sulfur dioxide intake. Intensive studies of the needles indicate differences between sensitive and non-sensitive spruces in terms of water circulation, glycides, amino acids, and potassium levels. These results can be practically utilized in forestry by providing valuable help in cultivating forest trees which are smoke resistant.
Source: 1

#580

Pesek , F. "The reduction of fruit quality by industrial aerosols." Rostlinna Vyroba (Czech), 11:837-852 (1965).

A droplet analysis method for determining the intensity of industrial smoke products (soot, dust, and ash) on the surface of fruit is described. The method involves removing the products from a one sq cm section of fruit, placing the products in one cc clean or distilled water, then transferring the resulting solution to glass slides for microscopic examination. The method give more precise and more reliable results than that in which the epidermis of the fruit is placed under the microscope and the fruit evaluated by weight. Based on observations in fruit-growing regions of Czechoslovakia, smoke products damage fruit in both the period of blossoming and the development of fruit. Blossoms damaged by the products produce deformed fruit with little resistance to disease. Moreover, the smoke products combine with the wax on the surface of the fruit to form an organo-mineral layer that is insoluble in water and which by interfering with the penetration of solar radiation, affects the coloration of the fruit.
Source: 1

#853

Pesek, F. "Biochemische Phenomane in Boden Exhalationsgebiete." (Biochemical phenomena in the soil in exhalation areas). Air Pollution Proc., First European Congr. Influence Air Pollution Plants Animals, Wageningen, 33-39 (1968).

To study the problems connected with soil poisoning, it is necessary to know the concentration of substances emitted from the suspected industrial sources and the amount of exposure time. Chemicals which were found in quantities between 0.01 and 1.9% in diseased soil in the region of Bohemia are presented tabularly. Toxicity limits and physiological thresholds are necessary to provide a prognosis and therapy in emission areas. An equation is provided indicating the sterility of the soil toward vegetation.
Source: 1

#98
Peters, L.N., and J.P. Witherspoon. "Retention of 44-88-μ simulated fallout particles by grasses." Health Physics, 22:261-266 (1972).

A quartz fallout simulant containing ^{134}Cs was deposited (1.85 g particles/ft^2) on 4 common species of grasses used for pasture or turf purposes (Zoysia, Bluegrass, Fescue and Bermuda). Initial interception of the fallout simulant varied between species from 68 to 82%. Weathering half-lives of particles on foliage average 3.5 ± 0.6 S.E., 36.7 ± 8.6 S.E. and 80.5 ± 39.5 days, respectively, for time periods of 0-2.5, 2.5-35 and 35.48 days following deposition. Particles lost from foliage were mostly trapped by dense mats of stem and dead foliage, and transfer of particles to the soil surface amounted only to 31% of the original deposition at 48 days. Thus fallout contaminated grasses might be expected to receive greater radiation doses and retain more radioactivity for food chain transfers than other agricultural plants with less effective structures for particle retention.
Source: 7

#350
Peterson, P. J. "Unusual accumulations of elements by plants and animals." Sci. Prog., Oxf., 59(236):505-526 (Winter 1971).

The accumulation of certain elements to very high levels by plants and other organisms is outlined. In higher plants, the ability to accumulate elements and to survive on soils containing toxic quantities of various elements occurs sporadically throughout different species, but in lower plants a higher concentration of some elements is typical of a particular order. Elements accumulated by some higher plants include copper, strontium, calcium, zinc, rare earths (the hickory tree), aluminum, silicon, and nickel. Among lower plants, algae accumulate iodine and bromine dusti fungi, selenium and vanadium; mosses, copper, boron, and vanadium; lichens, ytrrium, gallium, tin, and lead; horsetails, silicon and zinc; lycopods, aluminum; and ferns, ytrrium and uranium. Copper, cadmium, arsenic, barium, and fluoride are accumulated by certain marine organisms. Mammalian accumulator tissues exist for many elements including iodine, titanium, aluminum, vanadium, zirconium, and selenium. Some of the mechanisms which may enable an organism to survive an accumulated element are: the toxic element is excluded or partially excluded from the cells; the element is confined to the cell well; the element enters the cell and is metabolized to possibly inactive components or by binding with another compound.
Source: 1

#1665
Peukert, Volkmar. "Untersuchungen des Einflusses atmosphaerischer Verunreinigungen auf die Wasserbeschaffenheit der Gewaesser." (Study of the influence of atmospheric pollutants on the water composition of water bodies). Wasserwirt.-Wassertech., 24(5):158-161 (1974).

Examinations of the water in brooks in the Erzgebirge flowing through a spruce forest entirely unpopulated revealed extremely low pH values between 3.9 and 5.5. The arithmetic mean of 62 sample yielded a pH of 4.7 which is lethal for all fish and most microorganisms, which explained the absence of trout, formerly so abundant in these waters. Measurements of the pH in precipitations such as rain and snow yielded extremely low values. The sulfur dioxide concentration of the atmosphere was revealed as the cause. This gas, emitted primarily by industry, is dissolved in water and forms sulfuric acid. The extremely high sulfate concentrations measured in precipitations support this. In the vicinity of urban areas, sulfate concentrations as high as 700 mg/l were measured. In remote, hardly industrialized areas concentrations of up to 200 mg/l were measured. Generally, the concentration was found to fluctuate between 10 and 70 mg/l. The arithmetic mean of 218 measurements was 41 mg/l. The sulfate values of snow with 10 mg/l were clearly below those of rain. The concentrations of cadmium, manganese, iron, copper, zinc, cobalt, silver, and lead, which were also measured in the precipitations, were below the toxic limits. At times the phosphate concentration in the examined brooks far ahead of any entry of wastewater rose to 23 mg/sq m. In this case, the amounts came from atmospheric washout with the rain. This explains the extensive algae growth at times in the drinking water reservoirs.
Source: 1

#1588
Peyton, T., A. McIntosh, and V. Anderson. "A field study of the distribution of aerially deposited trace elements in an aquatic ecosystem. 1. Sediment component." Missouri Univ., Columbia, Environmental Trace Substances Center and National Science Foundation, Washington, D. C., RANN Program, Trace Subst. Environ. Health Proc., Annu. Conf., 8th, Columbia, Mo., p. 193-201 (June 11-13, 1974).

The distribution of aerially-deposited metals in a man-made aquatic system viz., a borrow pit, exposed to urban-industrial sources of air pollution was studied. Sediment levels of cadmium, zinc, lead, copper, and iron were 1.82, 481.0, 354.0, 52.1, and 40,524.0 ppm (top 5 cm of core samples) as compared to control values for a rural pond of 0.20 or less, 25.0, 5.0, 10.0, and 6300.0 ppm, respectively. The distribution of the metals in the exposed system was a function of basin depth and slope, point sources, and water currents. The majority of metals were found in aggregate silt fractions, indicating a binding capacity of silt for aerially deposited metal-bearing particulates.
Source: 1

#1589
Pickwell, G. V. "The physiology of carbon monoxide production by deep-sea coelenterates: Causes and consequences." Ann. N.Y. Acad. Sci., 174(1): 102-115 (Oct. 5, 1970).

Coelenterates of the order Siphonophora are known to occur in considerable numbers in productive near-shore areas of much of the world's oceans. Among the Siphonophora, two suborders, the Cystonectae and Physonectae Posses gas-filled floats, or pneumatophores, that are inflated by carbon monoxide. Because of the floats and the additional feature of explusion through an apical pore in the float of bubbles resulting from expanding gas during migration, the physonect siphonophores constitute important biological targets for acoustic echo sounders. They further contribute to an as yet undefined system of dissolved CO in the sea, with possible implications for atmospheric pollution. Experimental data are presented on siphonophore float dimensions and volumes, float elasticity, rate of oxygen consumption, and CO production of the pneumatophore alone, and oxygen consumption of intact siphonophores. Related parameters having to do with the supply and utilization of energy and gas are also examined. Physonect siphonophores can survive a partial pressure of CO equivalent to 45 atm. The siphonophore floats transmit CO to the surrounding water by diffusion, but they are unlikely to be the source of high surface CO values.
Source: 1

#1666
Pilet, P.-E. "Action du fluor et de l'acide beta-indolylacetique sur la respiration des tissus radiculaires." (The effect of fluorine and of beta-indolacetic acid on the respiration of root tissue). Rev. Gen. Bot., 71(836):12-21 (1964).

The effect of various concentrations of BIAA and of fluorine in the form of sodium fluoride on the growth of apical root fragments of Lens culinaris was studied. At all concentrations, BIAA inhibited the elongation of the root fragments, fluorine had the same effect at high concentrations but at low concentrations had a stimulatory effect on the growth of the root fragments. BIAA was found to stimulate respiration mildly at low concentrations while it inhibited the absorption of oxygen at higher concentrations. Acting in combination, no additive effect was noted. At concentrations stimulating respiration, fluorine was found to reduce the acceleration effect caused by BIAA. Thus fluorine and auxine acted as antagonists in their effect on the respiration of root fragments of Lens culinaris.
Source: 1

#1185
Pinkard, J. J., "Trees - regulators of the environment." Soil Conservation, pp. 56-57. (No date)

This article emphasizes the importance of trees in our environment; as windbreaks, as sources of food and shelter for animals, as noise reducers, as oxygen producers, and their cooling effects. Each 100 ft.of forest is believed to be capable of dissipating 6-8 dB of sound. Daily evaporation from one well-watered tree produces an estimated cooling effect of 1 million Btu's. A growth of 1 ton wood releases 1.1 tons O_2 and absorbs at least 1.5 tons CO_2. Trees absorb polluted air and emit air richer in O_2 and somewhat freer of pollutants.
Source: 6

#649
Piskornik, Zdzislaw and Stefan Godzik. "Oddzialywanie zanieczyszezen powietrza na rosliny." (Effect of air pollution on plants). Wiad. Bot., 14(2): 91-102 (1970).

Some aspects of sensitivity of plants for phytotoxic agents (sulfur dioxide, fluorine and chlorine compounds, ozone and other oxidants) and of the changes in plant physiology are discussed. Discussion is based on the literature. The role of ecological factors (atmospheric and soil humidity, sun-light conditions, temperature and the content of minerals in soil) which mitigate pollution impact, are shown. The age of foliage also modifies plant sensitivity to pollution. Foliage on middle age is most sensitive. Some gaseous phytotoxic compounds accumulate in leaf cells (SO2, fluorine and chlorine compounds). The changes in physiological processes, especially in photosynthesis, are a measurable and sensitive indicator of plant reaction to pollution. The disturbances in enzymatic processes, i.e., changes in activity of a number of enzymes caused by SO2, ozone, fluorine compounds, and substances of photochemical origin, are discussed.
Source: 1

#1667
Pisut, Ivan. "Bemerkungen zur Wirkung der Exhalationsprodukte auf die Flechtenvegetation in der Umgebung von Rudnany (Nordostslowakei)." (Comments on the action of emissions on the lichen vegetation around Rudnany (Northeast Slovakia)). Biologia, 17(7):481-494 (1962).

Qualitative and quantitative changes in the epiphytic, epigeal, and epipetrous lichen flora around an iron ore-processing plant emitting sulfur dioxide and mercury in Rudnany (Northeast Slovakia) were studied. Within a radius of 2550 m around the plant, the SO2 concentrations ranged from 0.005 to 0.015 mg/l. Increases in both the number and abundance of the lichen species with increasing distance from the emission source were determined. Three different pollution zones around the industrial plant were distinguished on the basis of the lichenological study; in strongly exposed zones in which higher plants also were damaged, all lichen species but a few specimens of epipetric lichens were absent. In a second, moderately exposed zone where no damage to higher plants were visible, both epiphytic and epigeal species, as well as Cladonia sp. were present. Cladonia spp. and Baeomyces roseus were the dominant species in this zone. In a third, slightly polluted zone, normal development of epiphytic associations and dominance of Xanthoria parietina, Physcia grisea, Ph. orbicularis, Parmelia physodes, and P. sulcata were observed.
Source: 1

#1186
Pittman, S. "Pollution, parks and plane trees." A Paper read at the Public Works and Municipal Service Congress during the Session Under the Auspices of the Inst. of Park Admin., pp. 22-26, January 1961.

Pollution is damaging to vegetation and property in terms of money and public health. Effects of air pollution on plants is discussed. To overcome growing plants in a polluted area: (1) choose planting material that seems to survive well, (2) have a trial area where pollution resistance of an untried species can be experimented upon, (3) soil should be tests for limerequirements and supplied w/manure and fertilizer yearly, (4) nurseries should be located in the cleanest possible area, (5) greenhouse glass should be washed often to minimize light loss, (6) in winter, keep humidity fairly low as SO_2 damage occurs most severely w/ high humidity, (7) traffic islands with vegetation should be built upon a retaining wall at least 2 ft. high to protect it somewhat from traffic exhaust fumes.
Source: 6

#650
Plagnat, Francois. "Gui, fumees industrielles et forets de Maurienne (Savoie)." (Mistletoe, industrial fumes and the Maurienne Forests (Savoie)). Rev. Geog. Alp., 59:326-342 (1971).

Attention is drawn to the dramatic situation of the fluorine-damaged Maurienne Forests. The first damage of these mistletoe forests, consisting of 90% coniferous trees, were observed in 1910 when nearby aluminum production started. The upper limit of the fluorine damage rose successively to altitudes of 1600 and 2200 m, while the attack of mistletoe was unimportant above 1000-1400 m. Now, a forest area of nearly 10,000 ha is affected. The damage caused to mistletoe aggravated by the severe damage due to hydrofluoric acid. The losses due to smoke damage show an increase of 58% in the period 1956-1968, compared to the period 1950-1955. At the same time, production by the nearby aluminum plants increased from 43,000 t/yr in 1954 to 92,000 t/yr. The total fluorine emission is 1820 t/yr. Gas cleaning should be introduced. Irrespective of such steps, however, experiments are being carried out with American smoke-resistant Thuya plicata in a 75 ha-area. Measures by the newly-established Department of Environmental Protection are anticipated.
Source: 1

#1125
Podgerow, H. W. "Plantings as dust filters." (Translated from German for APTIC by Belov and Assoc., Denver, Colorado) les Khoz. 20:39-40 (1967).

Dust which precipitated on needles of pines and leaves of birch trees and aspen trees was quantitatively measured. Also, the surface of the leaves (needles) was determined and those leaves (needles) of identical appearance detain the dust differently depending on their specific location and the crown of the tree. Also, it was concluded that distance from the source of atmospheric contamination was a factor in the amount of dust deposited. Other factors include age, surface, depressions, and movement. A formula was used to determine the amount of dust precipitated and there are four tables of data.
Source: 6, 8

#651

Podzorov, N. V. "Fotosintez i dykhaniye sosny v zavisimosti ot stepeni zagryazneniya atmosfernogo vozdukha." [Photosynthesis and respiration of pine trees dependent on the degree of air pollution]. Tr. Gl. Geofiz. Observ. Im. A. I. Voikova, 238:232-235 (1969).

The harmful effects on pine trees of flue gases from industrial plants were investigated. The intensity of basic physiological processes in pine trees (photosynthesis and respiration) was measured in relation to the extent of damage from industrial emissions; to sulfur dioxide concentrations in the atmosphere; and to the distance from the source of pollution. Colorimetric methods were employed. Trees with maximum damage (more than two thirds of the tree was dry) had five times fewer needles than undamaged ones, and the surface area of their needles was smaller. The intensity of photosynthesis and respiration increased with distance from the pollution source, and was considerably lower for severely damaged trees. Thus the presence of SO2 in the atmosphere disturbs basic physiological functions of the pine tree. Sulfur dioxide concentrations 0.23-0.32 mg/cu m causes a rapid disturbance in photosynthesis which results in the drying of trees within 2-3 years. Concentrations of 0.23-0.08 mg/cu m lead to slow drying in 5-7 yrs as a result of the decrease in photosynthesis intensity.
Source: 1

#1252

Poglazova, M.N., G.E. Fedoseeva, A.J. Khesina, M.N. Meissel, and L.M. Shabad. "Destruction of benzo(a)pyrene by soil bacteria." Life Sci., 6(10):1053-1062 (1967).

Data are given on the presence of bacteria capable of accumulating and destroying the carcinogen, benzo(a)pyrene, which is found in the air and soil of large modern cities. Samples collected on the land of an old oil refinery contained up to 200 mg of benzo(a)pyrene per kilogram of soil. Seventeen strains of spore-forming bacteria, some of which belong to the Bacillus megaterium species were isolated from soil samples and grown on meat infusion agar. The cultivated bacteria accumulated and destroyed the benzo(a)pyrene in the nutrient media and in the soil. It was possible to increase the ability of the soil bacteria to destroy benzo(a)pyrene by prolonged cultivation in media containing the hydrocarbon. The benzo(a)-pyrene content of the samples was followed by quantitative spectral fluorescent methods. A fundamental method of biologically reducing the carcinogenic hydrocarbons in the soils is given.
Source: 1

#1253

Poglazova, M. N., G. E. Fedoseeva, A. Ya. Khesina, M. N. Meisel, and L. M. Shabad. "The oxidation of benz(a)pyrene by microorganisms in relation to its concentration in the medium.." Dokl. Biol Sci. (English translation from Russian of: Dokl. Akad. Nauk SSSR), 179(2):199-201 (March/April 1968).

The oxidation of benz(a)pyrene (BP) by Bacterium megaterium mutilate was studied using meat-peptone broth cultures and soils contaminated by hydrocarbons in industrial waste. In both cases, the oxidiative capacity of the bacteria was directly dependent on the BP concentration, increasing with increased concentration. However, the amount of BP destroyed was significantly higher for microorganisms cultured in soil than for those grown on the meat-peptone broth. At a BP soil concentration of 130 mg/kg, the bacteria oxidized 80-85% of the bacteria. In a related experiment, natural soil microflora were also found to be highly effectively in destroying BP in soil when present in high concentrations. These observations show that the metabolic activity of bacteria is one of the most important factors in the destruction of high concentrations of carcinogenic hydrocarbons in soil. This process can be regulated either by the quantitative content of aromatic hydrocarbons or by differences in composition of the microflora.
Source: 1

#854
Pogrebnyak, P.S. "The effect of industrial gases and industrial smoke on various forest species." In: American Institute of Crop Ecology Survey of USSR Pollution Literature. Vol III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union. M.Y. Nuttonson (ed.)., Silver Springs, Md., American Inst. of Crop Ecology, p.1-2 (1970). Also: Obshchee lesovodstvo, Vtoroe isdanie (General Forestry, Second Edition), Moscow (USSR), Kilos, p.215-217 (1968).

The problem of protecting forests against industrial gases primarily concerns evergreen conifers, whose leaves are continuously poisoned and usually dead in the second year. Evergreen conifers damaged by sulfur dioxide also suffer partial loss of current leaves along the edges of the crown, and this in turn causes thin foliage. Resistant conifer species that are recommended for growing under conditions of moderate air pollution are larch, Colorado spruce, Engelmann's spruce, Serbian spruce, arborvitae, junipers, lodgepole pine, and false cypress.
Source: 1

#652
Pollanschuetz, J. "Erfassung der als Folge von Immissionen eingetretenem Zuwachsverluste." (Determination of increment losses caused by emissions). Schweiz. Z. Forstwesen, 117:798-808 (1966).

A mathematical approach for the evaluation of wood damage caused by pollutants is presented. Three basic categories of damage are reviewed. The first category refers to acute effects produced by high concentrations of toxic pollutants and leading to death of entire wooded areas. The second and third categories include chronic damage affecting the growth rates of different trees of a certain population. The calculation of damages focuses on these latter categories; the annual ring increment is the basic element applied. Ratios such as measured annual rings compared with expected annual rings are considered as annual ring indexes. Comparisons between annual ring indexes of damaged trees and those of healthy trees produce the relative index (RI). Dividing the established radial increment of damaged specimens through the appropriate RI, a useful evaluation of the radial increment without the bark is obtained. Knowing these data, the formula for the computation of total increment loss can be applied.
Source: 1

#654
Pollanschuetz, J. "Methodik der Rauchschadensfeststellung, wie sie gegenwaertig von der Forstlichen Bundesversuchsanstalt angewandt wird." (Method for smoke damage determination as it is presently applied by the Federal Forestry Research Institute). Mitt. Forst. Bundesvers., 73:81-89 (1966).

In the case of suspected smoke damage, needle and soil samples are analyzed, and the proper investigations are performed to determine chronic emission. Both diagnosis and damage calculations should be based on a series of consistent phenomena instead of on isolated symptoms and findings. The results of visual inspection only indicate possible smoke damage. As a first step, orographic conditions, character, direction, speed, and daily distribution of air movements are investigated. The test points are marked depending on the dominant wind direction, with special regard to the suspected pollution source, or the prevailing pollutant. In choosing the test points, the comparability of the test stands is of great importance, particularly in the case of chronic emissions. In the second step of the investigation, air and needle analyses and growth measurements are carried out, with emphasis on radial growth measurements. All investigations should be centered on determining the economic damages and consequences instead of on physiologic effects of the emission; physiological damages do not necessarily imply economic losses.
Source: 1

#855
Poovaiah, B.W. and H.H. Wiebe. "Tylosis formation in response to fluoride fumigation of leaves." Phytopathology, 59:518-519 (April 1969).

Occurrence of tyloses in the petiole of geranium plants fumigated with fluoride gives evidence that injury may influence function of tissues some distance from the actual site of visible damage. In the early stages of hydrogen fluoride fumigation, light-brown colored areas appeared at the white margins of leaves; these buco necrotic zones spread as the fumigation was prolonged. Intermediate-age leaves were injured more severely than either younger or older leaves. All tissues were affected in severely injured edges, although some upper epidermal cells still appeared nearly normal. In the zone adjacent to the severely injured area, the upper half of the leaf was normal, while the spongy mesophyll cells became plasmolyzed and collapsed. Distortion of chlorplasts and starch grains was noted in parenchyma cells near the injured areas. Severely injured and necrotic regions stained very heavily with safranin. The first occurrence of injury in the spongy mesophyll is consistent with the suggestion that fluoride enters mainly through the stomata. Fluoride effects are more evident in the vascular region than other areas, and it is possible that the fluoride damage produces early senescence that in turn causes the tyloses to form. In the phloem, cylinder-like depositions were noted on sieve plates which were identified as callose by strong fluorescence when stained with anilne blue and illuminated with ultraviolet light.
Source: 1

#1668
Poovaiah, B.W. and H.H. Wiebe. "Effects of gaseous hydrogen fluoride on oxidative enzymes of Pelargonium zonale leaves." Phytopathology, 61:1277-1279 (1971).

Changes in peroxidase and cytochrome oxidase enzymes were established histochemically in hydrogen fluoride fumigated leaves of Pelargonium zonale. Highest peroxidase and cytochrome oxidase activities were localized near the injured areas of fumigated leaves and showed an enhanced benzidine blue coloration in the phloem, with a decreased color or its complete absence in the palisade parenchyma. The enzyme activity was clearly evident in the phloem even after surrounding mesophyll cells had collapsed. Parallel experiments conducted on leaves infiltrated with sodium fluoride solutions showed similar results, though peroxidase activity was inhibited by fluoride levels higher than 0.01 M for 6 hr of bathing.
Source: 1

#104
Porter, L.K., F.G. Viets, Jr., and G.L. Hutchinson. "Air containing nitrogen-15 ammonia: Foliar absorption by corn seedlings." Science, 175:759-761 (1972).

Thirty-day old corn seedlings, grown in the greenhouse with different concentrations of supplemental nitrate nitrogen, were moved to a constant-temperature growth chamber and sealed in a 560-liter tent made of polyvinyl chloride. The plants were exposed to air containing ammonia labeled with nitrogen-15 (1, 10, and 20 parts per million) for 24 hours and then harvested. The nitrogen-15 content of the tops and roots showed that at 1 part per million, 43 percent of the ammonia was absorbed, whereas at 10 and 20 parts per million, 30 percent of the ammonia was absorbed. The results demonstrate that growing plants may be a natural sink for atmospheric ammonia.
Source: 6

#295
Posokhov, Y.V. "Factors forming the chemical composition of precipitation." Sov. Hydrology, Selected Papers, 6:640-652 (1968) and Gidrokhim. Materialy, 46:15-31 (1968).

The chemical composition of precipitation is influenced by a number of factors. Over the continents the key role is played by aerosols whose composition is determined by the composition of the soils and rocks, the presence of vegetation, climatic, meteorological, and orographic conditions. In coastal regions the aerosols suspended in the air are either of marine or continental origin, depending on soil-geological, climatic, and meteorological factors. The influence of these various factors on the chemical composition of precipitation is discussed, as well as studies which support the various hypotheses. Volcanoes, thermonuclear reactions occurring on the sun, and large industrial centers are also mentioned.
Source: 1

#1592
Pressman, J., L. M. Arin, and P. Warneck. "Mechanisms for removal of carbon monoxide from the atmosphere." (Final Report). GCA Corp., Bedford, Mass., NAPCA Contract CPA 22-69-36, GCA-TR-70-6-G, 42 p. (April 1970). CFSTI: PB 192188.

Results are presented from theoretical and laboratory investigation to identify natural chemical processes by which carbon monoxide is oxidized and removed from the atmosphere. Three aspects were studied. Photochemical CO oxidation in the stratosphere is a significant sink for CO, removing 11-15% per year of the total CO inventory of the troposphere on the basis of the reaction, OH plus CO yields CO_2 plus H. Reaction of CO with ozone in the troposphere does not provide a significant CO sink. However, the oxidation of CO by ozone is catalyzed by methane present in the CO as an impurity in the ppm range. Since methane is a significant trace constituent in the troposphere, further study should be directed toward the possible importance of a catalyzed Co oxidation by ozone as a removal process. In exploratory experiments of CO oxidation in aqueous solutions by pH measurements, simple sodium chloride solutions in concentrations found in seawater promoted the interaction of CO and oxygen. However, studies reporting the oceans as a source of CO suggest that, on net balance, the catalytic oxidation of CO in seawater does not offer the promise for future research of other potential removal processes.
Source: 1

#965
Pressman, J., and P.Warneck. "The stratosphere as a chemical sink for urban monoxide." J. Atmos. Sci., 27(1):155-163 (1970).

Past and recent data on atmospheric CO levels indicate no significant increase of average concentrations-despite the increasing anthropogenic emission rate-so that one or more natural sinks for CO seem to be operative. It is shown that the stratosphere provides a sink for CO on account of the reaction $OH+CO \rightarrow CO_2+H$. The radical OH is produced photochemically in a moist ozonosphere with a time constant several orders of magnitude less than that of the CO oxidation reaction, so that almost all the CO entering the stratosphere will be destroyed. The rate limiting factor is the transport of CO rich air through the tropopause. To determine the significance of the stratosphere sink, two theoretical models for the tropospheric CO behavior are considered. Although the theory provides several constraints for the rate of CO removal from the derivation of a reliable value for the total CO removal rate. An estimate indicates that the stratospheric sink contributes significantly, but only partially, to the overall removal of CO from the atmosphere.
Source: 5

#1003
Prey, A.J. "Pines monitor air pollution." Wisc. Cons. Bull., 33(4):24-25 (1968).

Air pollution injury to crops, known in the past on the east and west coasts, has come to Wisconsin. Some white pine trees are susceptible, and also tobacco. The loss is indicative but so far is relatively low in our state.
Source: 5

#1669
Prica, Vladimir. "Dinamika nagomilavanja ukupnog sumpora u listu nekih vocaka u uslovima aerozagadenja kao pokazatelja zagadenosti vazduha." (Accumulation dynamics of total sulfur in leaves of some fruit trees in the conditions of aerial pollution). Savremena Poljopr., 21(11-12):83-94 (1973).

The accumulation dynamics of the total sulfur in leaves of selected fruit trees were followed in order to establish whether total sulfur analyses can be used as an indicator of the level of pollution by sulfur dioxide. Analyses were performed on fully developed leaves of uniform age which were without necrotic damage by SO_2. All examined varieties retained their natural feature to accumulate S in leaves during vegetation both in unpolluted and polluted localities, with the consequence of SO_2 presence being the difference in levels of S accumulation. The process of accumulation and final results were determined through the examination of fruit varieties, climatic conditions, and localities. The analysis of total S in a developed leaf performed in July and September was a reliable indicator of the pollution levels in certain localities near a pollution source. Necessary conditions were the choosing of a suitable plant-indicator found was a plum tree at the stage of full fruit bearing, with leaf samples being taken from the outer twigs.
Source: 1

#1670
Price, Harvey and Michael Treshow. "Effects of ozone on the growth and reproduction of grasses." Proc. Int. Clean Air Conf., Melbourne, Australia, 275-280 (May 15-18, 1972).

Fumigation studies were undertaken to determine the effects of photochemical pollutants on the productivity and reproductive potential of Gambel Oak and Quaking Aspen, the most important watershed communities of the Wasatch Mountains of Utah. Sensitivity thresholds, based on visible injury, for a species were determined by fumigating transplanted plants with 5-35 pphm ozone for 4 hr. Once the sensitivity threshold was established, the species was fumigated consecutively for 5 days to determine the acute threshold. This was the level at which daily tissue injury occurred and was generally 3-4 pphm higher than the sensitivity threshold. To determine the effects of long-term ozone fumigation, a regime of 15-18 pphm for 1 hr, 28-33 pphm for 2 hr, and 18-20 pphm for 1 hr was followed during the life cycle fumigation of selected plants. Leaf length and number, total dry weight of plant, and weight and number of inflorescences and florets were measured as parameters of productivity and reproduction. The results indicate a potential decline in the plant populations studied can occur under conditions producing chronic injury to leaf tissue. Automotive exhaust emissions must be controlled and ozone concentrations prevented from exceeding 20 pphm.
Source: 1

#230
Prince, R. and F.F. Ross. "Sulphur in air and soil." Water, Air, Soil Pollut. 1(3):286-302 (July 1972).

The sulfur needs of vegetation, natural sources of airborne S, anthropogenic emissions, manufactured S, maximum permissible concentrations, emissions and concentrations, sulfur dioxide absorption, S in precipitation, S loss in drainage, and future trends are discussed. Natural S supplies are insufficient for high crop yield. The S brought down by rain is limited, even in industrial areas, and much of it is lost in drainage. Additional supplies are needed either as fertilizers or as sulfur dioxide, which vegetation readily absorbs. The margin between the minimum SO2 concentration for full growth and the concentration at which damage occurs is wide enough for distribution via the air, without deleterious effects, of such S as is available from the combustion of fuels. The three major questions where more precise quantification is required relate to urban pollution, absorption by land and water surfaces, and long distance drift. Suggestions for future research are given.
Source: 1

#351
Pringle, B.H., D.E. Hissong, E.L. Katz and S.T. Mulawka. "Trace metal accumulation by estuarine mollusks." J. Sanit. Eng. Div. Proc. Am. Soc. Civil Engrs., 94(SA3):455-475 (June 1968).

Mollusks in the natural estuarine environment appear to accumulate trace metals at different rates and attain tissue levels according to the environmental concentration of the particular metal, temperature, the species concerned, and the physiologic activity of the animal itself. The apparent selectivity for trace metals among various molluscan species appears to depend to a considerable extent upon the metals available in the environment; their chemical and physical properties; the kind and number of ligands available for chelation, transport, and storage; and the stability of the complex formed. Relative toxicities of the various metals also play a prominent role. In a simulated natural environmental system, accumulation rates and the tissue levels of the trace metals are dependent upon the environmental metal concentration, temperature, time of exposure, and the particular species used. Data indicating the uptake and concentration rates of approximately 10 trace metals in the Northern Quahaug, a hard-shell clam (Mercenaria mercenaria), the soft-shell clam (Mya arenaria), and the American Eastern and the Pacific Oysters (Crassostrea virginica and C. gigas) in their natural environment are presented. In addition to these mollusks, results of studies with the common blue edible mussel (Mytilus edulis), the surf clan (Spisula soildissima), and the channeled whelk (Busycon canaliculatum) in a simulated natural environment using various concentrations of copper, lead, zinc, cadmium, and chromium are given. Brief reference is made to investigations of the anatomical uptake of lead in the Eastern Oyster, as well as depletion studies.
Source: 1

#655
Przybylski, Zdzislaw. "Wyniki obserwacji nad dazalaniem gazow i par SO2, SO3 i H2SO4 na Drzeiwa Owocowe i niektore szkodliwe owady w rejonie kopalni i zakladow przetworczych siarki w Machowie k/Tarnobrzega." (Results of observation of the effect of SO2, SO3, and H2SO4 on fruit trees and some harmful insects near the sulfur mine and sulfur processing plant at Machow near Tarnobrzeg). Postepy Nauk Rolniczych, 2:111-118 (1967).

The effects of sulfur dioxide, sulfur trioxide, and sulfuric acid generated by a sulfur-processing plant on fruit trees, insect pets, and their natural enemies were studied at distances of 0.5 to 3 km in all directions from the plant. The most negative action of SO2, SO3, and H2SO4 gases and vapors on the life of plants and insects appeared on the northeast, east, north, and southeast sides of the sulfur processing plants. The harmful action of these gases is observed to a small degree in a radius up to 3 km from the north side of the plants. Shields in the form of buildings or resistant trees clearly influenced the improvement of environmental condition in certain orchards. A ring of trees resistant to SO2 (for example, poplars) in a radius of 2 km around the plant would to a certain extent brake the transmission of plant gases to greater distances. The fruit tree pest most sensitive to the gases is the red fruit spider (European red mite). This pest constitutes to a certain extent an indicator for SO2, SO3, and H2SO4 gas and vapor concentration. Apple tree aphids are exceptionally resistant to the harmful action of the gases and their quantity was larger at observation points located 0.5 km from the plant. This would be evidence of lack of possibility of survival in this environment of the natural enemies of this pest.
Source: 1

#653
Przybylski, Z. "Wyniki kolejnej obserwacji nad dzialaniem gazow i par SO2, SO3 i H2SO4 na drzewa, krzewy i szkodliwa entomofaune sadow w rejoine kopalni i zakladow przetwortzych siarki w Machowie k/Tarnobrzega." (Results of consecutive observation of effect of SO2, SO3 and H2SO4 gases and vapors on trees, shrubs, and entomofauna of orchards in the vicinity of sulfur mines and sulfur processing plant in Machow). Postepy Nauk Roln. (Warsaw), 15(6): 131-138 (1968).

The effects of sulfur dioxide, sulfur trioxide, and sulfuric acid gases and vapors on the ecology of an area near a sulfur processing plant was studied. Harmful changes occurring within a 2 year period were observed on fruit trees, wild trees and shrubs. The most pronounced damage to plants occurred south-east, east, and north of the plant, and damage to trees was observed even 4 km away from the plant. Depending on the species of tree, symptoms of damage include yellowed leaves (apple trees), diminished leaves (pear trees), necrosis of leaf tissue and leaf drop. Fruit yields decreased because fewer bees were present during tree blooming. The occurence of a new fruit worm more resistant to the effects of sulfur compounds was observed.
Source: 1

#1671

Przybylski, Zdzislaw. "Resultats d observations relatives a l influence des gaz et vapeurs de soufre sur les arbres fruitiers, arbustes et arthropodes aux alentours des usines et mines de soufre dans la region de Tarnobrzeg." (Results of observation on the influence of sulfurous gas and vapors on fruit trees, shrubs, and arthropods around the sulfur mines and processing plants in the Tarnobrzeg Region). Environ. Pollut., 6(1):67-74 (Jan 1974).

The effects of an the damages due to sulfur dioxide, sulfur trioxide, and sulfuric acid emissions on plants and athropods around a sulfur mine and sulfuric acid production plant in Tarnobrzeg in Poland were studied in a 3-kilometer radius. Discoloration and early loss of the foliage in fruit trees, and the loss of green foliage without apparent changes in brush, conifera, and other wild trees were observed. Many trees in that region died due to exposure. Prunus anium L., Prunus cerasus L., Secale cereale L., Tritcum vulgare Vill., Conifera, Quercus sessils Ehrh., Tilia parvifolia Ehrh, Carpinus betulus L., Betula verrucosa Ehrh,,Corylus avellana L., and Sambucus nigra L. were especially susceptible to the emissions while Alnus sp. Mill., Syringa vulgaris L., Jugland regia L., Solanum tuberosum L. and Beta vulgaris var. saccharifera Lnge. were among the most resistant species. Absence or reduced number of arthropodes around the sulfur works was observed. Specimens of Carabidae, Cantharididae and Tettigoniidae were not found nearby the sulfur works, which indicates that these species can be used as indicators of SO2 emissions.
Source: 1

#304

Pueschel, R.F., H.T. Ellis, L. Machta, G.F. Cotton, E.C. Flowers, and J.T. Peterson. "Normal incidence solar radiation trends on Mauna Loa, Hawaii." National Oceanic and Atmospheric Administration, Silver Spring, Md., Air Resources Labs., Mauna Loa Observatory, Hilo, Hawaii, Environmental Protection Agency, Research Triangle Park, Div. of Meterology, p. 164-168 (1972).

Incident solar radiation measurements at Mauna Loa, Hawaii, are presented. The transmission factors presented are fractions of the apparent extra-terrestrial radiation in the Langley Plots, which is approximately 10% lower than the true solar constant. The transmission factors are shown as functions of time for 1958-1971. The quantitative relationships between transmission and time for the periods from Jan. 1958 to March 1963 and from April 1963 to Dec. 1971 are shown. The record revealed a seasonal variability with a minimum of atmospheric transmission in early summer. During a period of relative volcanic quiescence between 1958 and 1963, the amplitude of this periodicity was 0.4% of the annual average transmittance level. In April 1963, the station record experienced a sharp decrease associated with the dust from the March 1963 Mt. Agung volcanic eruption. Additional volcanic eruptions

subsequent to 1963 apparently delayed the recovery of atmospheric turbidity to its background levels. Since about 1969, the receipt of normal incident Solar radiation at Mauna Loa has been similar to that found before 1963. There has been no detectable trend in normal incident solar radiation due to the emission of particulate matter from human activities. Higher turbidities in summer may be due to longer aerosol residence times and greater particulate load of tropical atmosphere from higher lattitudes. The lower atmospheric transmissions during the summer could be the result of increased photochemical aerosol formation caused by the oxidation of volatile organic materials of plant origin. Increased atmospheric water content during the summer could yield higher turbidity values.
Source: 1

#1672
Purves, D. "Trace-element contamination of soils in urban areas." Trans. Int. Congr. Soil Sci., 2:351-355 (1968).

The spectrochemical analysis of top-soils from urban areas in Scotland indicates that in such soils, levels of copper, boron, lead, and zinc are substantially higher by comparison than are arable top-soils from rural areas. Urban garden soils, as a group, contain on the average about five times as much EDTA-extractable copper, twice as much water-extractable boron, four times as much acetic acid-extractable lead, and twenty times as much acetic acid-extractable zinc as rural, arable soils in South-East Scotland. These differences are so great that they must be due to contamination resulting from various kinds of human activity in urban areas. Sources of contamination and possible effects of the high levels on plants grown in urban areas are discussed.
Source: 1

#656
Purves, D. "Consequences of trace-element contamination of soils." Environ. Pollut., 3(1):17-24 (Jan. 1972).

The chemical composition of the bulk of food has been profoundly modified by the intensification of the means of food production and as a result of the general contamination of the environment. Contamination of the soil in urban and industrial areas with potentially toxic trace elements, e. g., copper, boron, lead, and zinc, is largely irreversible. Sources of soil contamination, the trace-element content of plants grown on contaminated soils, and the effects on plant growth are considered. Contrasts and comparisons are drawn for soils in urban and rural areas. The composition of materials commonly used in gardens, e. g., soot, coal ash, municipal compost, and sewage sludge, are likely sources of trace element contamination. The primary source of contamination in urban parklands is atmospheric pollution. The boron, copper, lead, molybdenum, nickel, and zinc contents of cabbages grown in urban and rural area were measured; the differences in mean levels for each element were highly significant.
Source: 1

#1673

Purves, D., and E. J. MacKenzie. "Trace-element contamination of parklands in urban areas." J. Soil Sci., 20(2):288-290 (1969).

Evidence is presented that soils in urban parklands are markedly contaminated with copper, boron, lead, and zinc. Zinc dibenzyl dithiocarbamate was used as the reagent for determining EDTA extractable copper in soils, while copper in herbage was determined by a spectrographic plant-ash method. Porous-cup spark excitation using boron-free graphite electrodes was used for the analysis of herbage and water extracts of soils with respect to B. Zinc in herbage and acetic acid extracts of soil was determined by atomic absorption spectrophotometry. Herbage from the same urban parklands contained significantly higher levels of Pb and Zn than herbage from permanent pastures in rural ares. (Author summary modified).
Source: 1

#1674

Puth, G., and U. Luettge. "Sulfitwirkung die Membranpermeabilitaet von Pflanzenzellen: SO_3 Hemmung des n-Butanol induzierten Betacyaninefflux dem Gewebe roter Rueben." (The effect of sulfite on membrane permeability in plant cells: SO_3(--) inhibition of the betacyanin efflux from red beet tissue induced by N-Butanol.). Text in German. Biochem. Physiol. Pflanzen., 164(2): 195-198 (1973).

A suggestion that the industrial pollutant sulfur dioxide and the related anion sulfite non-specifically effect plant membranes independent of a mere acid effect was tested using betacyanin efflux from red beet tissue as an indicator of membrane leakiness. Red beet was cut into 1 mm slices and washed 24 to 48 hours in aerated 0.1 mM calcium sulfate solution. The solution was repeatedly renewed until all red coloring was gone. The slices were then used for measurements of the betacyanin efflux. One such slice was placed into 0.1 nM phosphate buffer pH 7.2 plus n-butanol and sodium sulfite plus sodium sulfate so that the sodium ion concentration and the concentrations of SO_3 and SO_4 ions were combined. Following the efflux tests (2.5 to 12.5 min) the betacyanin concentration of the solution was colorimetrically determined at 546 nm. Sulfite did not induce excess permeability. However, SO_3 (--) appears to seal membrane leaks caused by butanol. Since SO_3 (--) drastically reduces n-butanol induced betacyanin efflux.
Source: 1

#581

Pyatt, F. Brian. "Lichens as indicators of air pollution in a steel producing town in South Wales." Environ. Pollut., 1(1):45-56 (July 1970).

The lichen flora of a given region depend on a multiplicity of factors, some of which act directly or indirectly on the lichen thallus. In addition, the lichen thallus is capable of exerting a modifying influence on the macro and micro-environment. The polluted center of Port Talbot, a steel town, has a

restricted number of crustose and rather depauperate species. This 'lichen desert' is quite small, possible because the atmosphere is not heavily polluted or because there is a rapid dilution of pollutants. With distance away from Port Talbot there is an increase in the number of lichen species and a change in the proportion of the various growth forms. Abutting the 'lichen desert' is a zone in which Parmelia sulcata, P. Saxatilis, Cladonia coniocraea, and C. fimbriata are the most widely represented species. This is followed by a further zone dominated by Usnea comosa, U. florida, Cetraria glauca, and Cladonia impexa in particular. It must be emphasized that the zones are not clearly defined: there is a gradation in growth forms and a gradual change in the abundance of various species.
Source: 1

#1676

Pyatt, F. Brian. "Plant sulfur content as an air pollution gauge in the vicinity of a steelworks." Environ. Pollut., 5(2):103-115 (Sept. 1973).

The development of industrialization in the important steel-producing town of Port Talbot, South Wales, is discussed. The atmospheric concentrations of sulfur dioxide in the region are surprisingly low, although high concentrations are encountered at some locations (e.g., around blast furnaces) and the concentrations of SO2 and smoke vary seasonally. Sulfur dioxide is taken into plants via adsorption in rain and dew, and via gaseous assimilation, mainly through stomata. Responses to SO2 pollution vary from species to sepcies, with atmospheric relative humidity strongly affecting plant susceptibility to the pollutant. Sulfur dioxide produces changes in the stomata, recellign of the thylakoids within the chloroplasts of beans, and necrosis of the terminal portion of the leaf blade. The sulfur content of lichens from the Port Talbot region was measured and compared with plants from other regions.. Plants from polluted areas generally had higher sulfur contents than plants from relatively nonpolluted areas. The relationship is affected by factors such as the absorption of gaseous pollutants by surrounding vegetation and degree of exposure. The plant sulfur content generally decreased with increasing distance from the pollution source, but local anomalies occurred. The following species were considered in some detail: Peteridium aquilinum; Quercus petraea; and Acer pseudoplatanus.
Source: 1

#1675

Pyatt, F.B. "Some aspects of plant contamination by airborne particulate pollutants." Int. J. Environ. Studies, 5:215-220 (1973).

The development and effects of industrialization in the steel producing town of Port Talbot in South Wales, U.K. The relative degree of plant contamination by particulate pollutants is assessed as a rapid, inexpensive, and easily applied method of detection of airborne particulate pollutants. The average weight of particulates on the leaves decreased fairly regularly with increasing distance from Port Talbot, except in an area near a motorway. Some of the effects of environmental factors on the degree of deposition are examined, including wind, height of leaves, and rain.
Source: 1

#352
Quellmalz, E. "Problematik der Fluor-Immissionsmessung." (Problems of fluorine emission measurements). Text in German. VDI (Ver. Deut. Ingr.) Ber., 164:77-83 (1971).

The correct interpretation of measurements of the fluorine content in air presents some difficulties. The effect of the fluorine can vary depending on the type of compound in which it is present. Biologically, plants are most strongly affected by hydrofluoric acid, animals by free ions of fluorine. In addition to free hydrofluoric acid, other gaseous fluorine compounds can be present in the air, some of which are harmless, whereas others can undergo subsequent reactions and become harmful. It may be assumed that fluorine compounds penetrate the plant surface both in the form of gas and aerosols. The usually ill effects of fluorine compounds in plant food on animals can often be completely neutralized by feeding the animals simultaneously with fodder containing minerals, Emissions of fluorine from industrial sources can have different effects as air pollutants, depending on the industrial process involved. For instance, emissions from blast furnaces containing fluorine carrying dust are often more harmless if alkaline substances, particularly lime, are prevalent in the dust. If acidic substances prevail, the fluorine emission becomes far more noxious.
Source: 1,2

#856
Quellmalz, Eberhard and Walter Oelschlaeger. "Fluorgehalte von Luft und Pflanzen in der Umgebung einer Ziegelei." (Fluroine concentration of the air and plants in the vicinity of a brick kiln). Staub, Reinhaltung Luft, 31(5):206-208 (May 1971).

Brick kilns emit fluorine in the form of hydrogen fluoride and silicon fluoride. This is particularly true when the crude material contains many fluorine and few alkaline components. Emission measurements were taken with impingers in the vicinity of a brick kiln. In the period from May to August, 49 air samples were taken and the fluorine content was determined. Average concentrations of 1.4 to 6.9 microgram/cu m were determined. In 1968, Bergerghoff units were set up in which gaseous fluorine and fluorine-containing particles were collected. In rural areas the fluorine concentration amounted to 0.1 mg/sq m/day; a maximum concentration of 7.44 mg/sq m/day was found in the vicinity of the brick kiln. Examination of grape leaves revealed that the fluorine concentration rose gradually during the growing season, from 4.2 mg/100 g dry substance on the first of July to 23.5 mg/100 g dry substance on the last day of October. In leave samples from rural areas, the concentration was 1.2 mg/100 g dry substance. In the foliage of peas and string beans, a 10-fold fluorine concentration was found, in spinach a 9-fold, and in lettuce, a 20-fold concentration of that found in the rural areas. No direct correlation between the fluorine content of the leaves and the leaf injuries could be determined.
Source: 1

#1677

Raay, A. van. "The use of indicator plants to estimate air pollution by SO2 and HF." Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 319-328 (April 22-27, 1968).

Indicator plants can be used to estimate damage to crops by air pollution, although they can never give an absolute measure. An indicator plant must be sensitive to a certain contaminant, and it must react with clearly visible specific symptoms, preferably at low concentrations. Sulfur dioxide and hydrogen fluoride pollution may be detected with plants that accumulate the contaminant or with simple measuring devices. Both symptoms and chemical analysis must be used to trace the source, the rate, and the extent of contamination. Indicator plants with a different reaction to SO2 and HF allow distinction in areas where both pollutants occur. Endive, lucerne, clover, buckwheat, and barley may be used to detect SO2, and gladioli and freesias for HF. By using these plants in many small plots it is possible to make the polluted area. The advantages of this method are low cost and immediate and easy indication of the pollution. The disadvantages are the possible non-specificity of symptoms and losses of the pollutant from the plant. Gladioli are being studied for a possible correlation between the fluorine content of leaves, or tipburn injury, and the fluorine concentration of exposed sticky papers.
Source: 1

#137

Rabinowitz, M. "Plant uptake of soil and atmospheric lead in Southern California." Chemosphere, 1(4):175-180 (1972).

It has been known for thirty years that adding lead to soil, often as an arsenate insecticide, results in lead uptake by plant roots, but only a slight increase in the lead content of the stems and leaves[1]. Recently with the increased use of leaded gasoline, it has been found that the tops of plants growing near roads contain an excess of lead, attributed to the accumulation of atmospheric lead from automobile exhaust on the plant surfaces[2]. In the past few years a number of experiments have been performed evaluating the relative uptake of soil versus air-borne lead by measuring the lead concentrations of soils, air and plants[3,4]. We employed a stable isotope technique to distinguish leads coming from soil and air.

In the field the isotopic compositions of soil and atmospheric leads are often identical because much of the soil lead originates from atmospheric fall-out. It was therefore necessary to prepare soil with an unusual isotopic composition. This was done by adding to clay loam soil, lead nitrate refined from lead ores of Joplin, Missouri, an area of isotopically anomolous lead which is not used in gasoline additives. Four batches of soil were prepared with total lead concentrations ranging from 100 to 1300 parts per million (ppm). The soil pH was 6.7. The water soluble nitrate form of lead was quickly bound to the soil. Only one to eight micrograms of lead returned to 100 ml of water solution from one gram of soil. This was analogous to the behavior of automobile exhaust lead, which falls as a realtively soluble halide but becomes quickly fixed to the soil[5].

Oats (Avena sativa) and lettuce (Lactuca sativa, var. Black-Seeded Simpson) were planted under lathe at UCLA.
Source: 7

#1678

Rabotnova, I.L., V.S. Somov, T.S. Bobkova, I.V. Zlochevskaya, L.N. Chekunova, I.F. Knyazeva, and S.I. Belen kiy. "O zavisimosti toksicheskogo deystviya ozona na drozhzhi ot nekotorykh komponentov i pH sredy." (The relationship between the toxic action of ozone on yeast and certain components and medium pH). Vestn Mosk, Univ., 5:47-51 (1971).

The relationship between the toxic action of ozone on yeast was investigated. Candida lipolytica (sensitive to the action of ozone) and Candida guillermondii (tolerant) yeasts were cultivated in wort for 24 hr at 27 C, separated from the medium by centrifuging, and added (2-5 million cells/ml) to a medium with different reduction properties, achieved by adding a series of ingredients of nutrient media, such as carbohydrates (glucose), hydrocarbons (centane, paraffin), and amino acids (cysteine, glutathione) to the water. Procedures for ozonization and the calculation of ozone concentration are described. Ozone was obtained from a laboratory ozonizer; ozone in the ozone-air mixture was 0.3 mg/1 and 10-12 mg/1, respectively. Experiments were repeated three times, with the oxidation reduction potential (ORP) and the rH2 values calculated for each test. The influence of the organic components of the medium on the biocidal action of ozone, and the toxic action of ozone in terms of medium pH were reviewed. All results are discussed.
Source: 1

#96

Radwan, M.A. and W.D. Ellis. "Clonal variation in monoterpene hydrocarbons of vapors of Douglas-fir foliage." Forest Science, 21:63-67 (1975).

Monoterpene hydrocarbons in foliage vapors from four Douglas-fir clones, two resistant and two susceptible to deer browsing, were compared by gas chromatographic analyses. Foliage was collected during the winter. Many chemical components were separated, but only 10 monoterpenes were identified. Different methods of sample preparation and vapor collection affected total volatiles and peak ratios, but with all methods tested foliage resistant to browsing produced more terpenes than that from susceptible clones. Results may have application in breeding Douglas-fir resistant to browsing.
Source: 7

#659

Rains, D.W. "Lead accumulation by wild oats (Avena fatua) in a contaminated area." Nature (London), 233(5316):210-211 (Sept. 17, 1971).

Wild oats growing in the Benicia-Vallejo area, exposed for 70 years to lead emissions from a smelter, were examined for lead accumulation. Initially, during the period of rapid growth (April - June), the lead concentrations decreased, but then increased substantially during ripening until autumn, when the plants were completely air-dry. The increase continued, accelerating after heavy rains in October and November, and reached a peak in December. Lead contamination in the new growth (1970-1971) was similar to that in the early samples of the 1970 season. To investigate the effect of rain, a series of leaching experiments were conducted on dried straw. The results of the experiments are tabulated.
Source: 1

#53
Rameau, J. L. B. "Lead as an environmental pollutant." In: International Symposium Proceeding Environmental Health Aspects of Lead, Oct. 2-6, 1972, Amsterdam. Published by Commission of the European Communities, Luxembourg, pp. 189-197 (1973).

This report starts with a survey of how plants and soil become contaminated with lead when petrol containing tetra-alkyl-lead is used.

It is advisable not to grow leafy vegetables in direct vicinity of motor roads.

The lead content of roadside grass in The Netherlands is not yet as high as to cause lead intoxication in cattle.

Nevertheless it is recommendable not to feed this grass or hay as only roughage.

Great attention has to be paid to sampling and analytic methods for lead.

The wide discrepancies of results between different laboratories point out the further need for interlaboratory comparability studies at an international level.
Source: 8

#657
Rancitelli, L. A. "Trace element content of Alaskan caribou and lichen." In: Pacific Northwest Laboratory Annual Report for 1971 to the USAEC Division of Biology and Medicine, Volume II: Physical Sciences, Part 2, Radiological Sciences. Battelle Northwest, Richland, Wash., Radiological Sciences Dept., Rept. BNWL-1651(PT2), UC-48, p. 15-17 (May 1972).

To elucidate the mechanisms responsible for radionuclide transport through the Alaskan food chain, a study was conducted of 15 elements in lichen and caribou, including silver, arsenic, bromine, cobalt, chromium, cesium iron, mercury, potassium, sodium, rubidium, antimony, scandium, selenium, and zinc. The measurements were made by instrumental neutron activation analysis using 200 mg aliquots of caribou liver, muscle and kidney tissue and lichen samples which were simultaneously analyzed for their radionuclide content. Preliminary results of the trace element analyses of caribou revealed some trace element patterns similar to those observed in marine and aquatic organisms. Trace element content data is given.
Source: 1

#1679
Rancitelli, L. A., K. H. Abel, and W. C. Weimer. "Elemental content of trace elements in vegetation collected at Centralia, Washington." In: Pacific Northwest Laboratory Annual Report for 1973 to the USAEC Division of Biomedical and Environmental Research, Part 3. Atmospheric Sciences. Battelle Memorial Inst., Richland, Wash., Pacific Northwest Labs., Atomic Energy Commission Contract AT(45-1):1830, p. 1690170 (April 1974).

Neutron activation analyses for 28 major, minor, and trace elements in vegetation (pasture grass, tree leaves, moss, and lichens) near a 1400 MW power plant in Centralia, Washington were performed and compared with values for lichen samples collected from a remote region in Alaska. The grasses were selected to reflect recent deposition and uptake, while mosses and lichens were selected for their ability to display long-term effects of pollutants. Concentrations of arsenic, mercury, antimony, and selenium in lichens near the power plant were: 7.2, 0.12, 0.99, and 0.60 micrograms/g, respectively, an order of magnitude higher than Alaskan samples. The concentrations of the other 24 elements did not reflect increased values around Centralia. Source: 1

#1680
Rand, W.E. and H.J. Schmidt. "The effect upon cattle of Arizona waters of high fluoride content." Am. J. Vet. Res., 8(46):50-61 (Jan 1952).

Observations of cattle that have been continually ingesting and absorbing fluoride from drinking water and from forage provide a direct confirmation of conclusions that have been derived from a study of the literature. Levels of soluble fluoride in the diet can be tolerated as high as 1 mg per kilogram of body weight per day over a long period of time with no ill effect, except possible slight mottling and wear of the teeth. A level of soluble fluoride in the diet of the order of 2 mg per kilogram of body weight per day may result in mottling and severe wear of incisor teeth that form during the period of ingestion, as well as lameness and stiffn emaciation, and wastes the fluoride. Conditions as observed in the Phoenix, Ariz., area substantiated conclusions previously drawn from the literature with respect to fluorine content of urine and bones as criteria of damage. The fluorine content of urine must be well above 10 ppm to indicate current consumption of fluorine in damaging amounts, while the fluorine content of the metacarpus must be above 4000 ppm to indicate an accumulated amount that would have any effect other than some slight mottling or wear of the incisor teeth. Source: 1

#658
Ranft, Horst. "Untersuchungen zur Rauchhaerte von Flechten und Moosen unter Schwefeldioxideinfluss." (Studies on the smoke resistance of lichens and mosses under the influence of sulfur dioxide). TERPLAN-Statni ustav pro uzemni planovani, Ustav krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiny, Sbornik Z Mezinarodni Konference, Prague, Czechoslavakia, p. 25-29 (Sept 1971).

The effect of sulfur dioxide on over 30 lichen species and about 20 moss species was studied in fumigation experiments of 22-60 hr. using SO2 concentrations of 0.6 ppm, 1.4 ppm, and 3 ppm. Judged by visible

changes in the appearance of the species (discoloration and necrosis, starting out usually from the external parts), the lichen species Parmelia furfuracca Ach., Hamaline (farinacea), Cladonia bellidflora Schaer, Cetraria clorphylla Vain., C. islandica Ach., Alestoria jubata Ach., P. physodes Ach., Cl. alcicornis Floerke, Cl. arbuscula Ragenh, Cl. rangiferina Weber, Cl. coniocraea Vain, and Umbilicaria hirsuta Ach., as well as the moss species Sphagnum spp., Anastrepta orcadensis Schiff., Polytrichum commune L., Polytrichum juniperinum Wild., Plaglothecum undulatum Br. Eur., Altrichum undulatum P. Beauv., Dicranum scoparium Hedwig., Hypnum cupressiforme L., Hylocomium splendens Br. Eur., Minium hornum L., Minium affine Blandow, and Lepidocia reptans Dum. were very sensitive to SO2. The lichen species Rhicocarpum geographicum Dc., Lecanora varia Ach., and Lecidea scalaris, as well as the moss species Pohlia nutans Lindb, and Dicranella hetromalia Schimp. were more or less SO2-resistant. Specimens of highland origin were usually more susceptible than lowland specimens of the same species. Considerable regression of Cladonia arbuscula, Cl. rangiferina, Cetaria islandica, Parmelia spp., C. chlorophylla, and C. pinastri in Erzgebirge (East Germany) was noted.
Source: 1

#1681

Ranft, H. and H.G. Daessler. "Rauchhaertetest an Gehoelzen im SO-2 Kabinenversuch." (Smoke-hardness test carried out on woods in an SO-2 chamber test). Flora (Jena), 159:573-588 (1970).

From 1967 to 1969, an assortment of approximately 200 varieties of wood plants were exposed to sulfur dioxide in chambers at the Tharandt smoke damage test field, simultaneously with the establishment of wood test areas in the vicinity of three major chemical plants. Leaf and needle sensitivity of the test plants was determined, as well as their regenerative ability at various times during the growing season. Methodology, damage patterns, and regenerative ability are discussed. Results were recorded as a priority classification based on damage of leaves and needles in five groups according to susceptibility, resistance of an assortment of willows, and a sequential list according to regenerative ability.
Source: 1, 6

#3

Rao, D. N. "A study of the air pollution problem due to coal unloading in Varanasi, India." (Presented at the International Clean Air Congress, 2nd, Washington, D. C., December 6-11, 1970, Paper MB-33E.) Preprint, International Union of Air Pollution Associations, 12 p. (1970).

A study was undertaken to investigate the relationship of particulate air pollutants to the growth and fruiting behavior of Mangifera indica L. and Citrus limon (L) Brium. F. The site selected for the study was an area near the Gravity Transhipment Yard at Maduadih, Varanasi, India. The area is seriously polluted by coal-dust emanating from the yard during unloading.

Dust particles settling on soil and leaf surfaces were collected in jars and quantities were expressed as kg/sq km/ month; the size of particles in microns and their density in sq mm area were determined. Meteorological parameters such as wind velocity, temperature, relative humidity, and rainfall were determined. Light reflected from surfaces of soil, of clean leaf, and of dust-covered leaf was measured. Trees of mango and lemon between the ages of six and eight years, were marked at the polluted site, their average crown areas were determined; leaves from the center and periphery of the top, middle, and base of the crown were collected and necrotic-leaf-area percentages were determined; carpels were collected at the time of flowering and their stigmatic surfaces were closely examined; fruit production rates (kg/year/plant) of these trees were estimated for the pre- and post-pollution periods. On the basis of the data obtained from field and laboratory studies, it is concluded that coal dust present in the air is of great nuisance to plants, especially at the time of flowering. It inhibits not only their energy conserving and releasing processes by interfering with gaseous diffusion, by reducing light intensity, by increasing surface temperature and by disintegrating chlorophyll pigment; but it also checks the very process of fertilization which is the prerequisite for fruit formation. To control dust pollution a thick fence of Pithecolobium dulce can be used. It provides an effective barrier for wind-breaking and thus keeps back the particulate pollutants.
Source: 1

#1949
Rasmussen , R. A. "Isoprene: identified as a forest-type emission to the atmosphere." Enviro. Sci. & Tech., 4(8):667-671 (August 1970).

The hemiterpene isoprene (2-methyl-1, 3-butadiene) until recently has not been considered to be present in natural plant products. Direct gas chromatographic, infrared, and mass spectrometric analyses of the air in contact with the plant foiliage for five common tree species confirm previous observations (Rasmussen, 1964) of the existence of isoprene as a plant product. Preliminary dates from surveying the dominant forest tree species of North America indicate that the frequency of occurrence of isoprene is similar to that of a-pinene although species differ. Isoprene has been resolved directly from the out-of-doors air over mango foliages in Panama at concentrations of 0.5 to 24 p.p.b. in 5 ml. of air. The biological and air chemistry fates of isoprene are discussed.
Source: 5

#95
Rasmussen, R. A. "What do the hydrocarbons from trees contribute to air pollution." Journal of the Air Pollution Control Association, 22:537-543 (July 1972).

Plant species release appreciable quantities of volatile organic substances to the atmosphere. The major compounds emitted are monoterpenes (C_{10}) like apinene, B-pinene, and limonene and the hemiterpene (C_5) isoprene. The rate

of emission of isoprene is light dependent and ranges between 0.04 to 2.4 ppb/cm^2/min/l for oak, cottonwood, and eucalyptus foliage. The rate of emission of a- and B-pinene and limonene is dependent on the rate of transpiration, structural integrity of the oil cells and resin glands, and temperature of the foliage. Rates of emission for conifer foliage range from 0.4 to 3.5 ppb/g/min/l. An inventory of North American forest regions for the frequency of occurrence of these chemicals released by different tree species showed that 15% was the lowest value for a specific forest-type that emitted terpenes to the atmosphere. More commonly 100% of the trees of a given forest-type emitted terpenes to the atmosphere. An average of 70% is typical of the United States forested regions as a whole. The annual contribution of forest hydrocarbon emissions to the air pollution problem on a global basis is reflected in the 175 x 10^6 tons of reactive hydrocarbons from tree foliage sources compared to the 27 x 10^6 tons from man's activities; in other words, there is 6.2-fold greater emission level from natural sources than from man made sources. The fate of these gaseous olefins in the atmosphere is undetermined.
Source: 1, 6, 7

#1593

Rasmussen, R.A. "Emission of biogenic hydrogen sulfide." Tellus (Uppsala), 26(1-2):254-260 (1974).

The biogenic production of gaseous sulfur compounds from terrestrial and marine sources were investigated. Gas chromatographic analyses using a flame photometric detector specific for sulfur at 394 nm indicate that dimethyl sulfide (DMS) and dimethyldisulfide (DMDS) are the major compounds in the gaseous emissions from bacteria and fresh water green and blue-green algae isolated from different soil types and eutrophic as well as naturally clean waters. Analysis of the S gases in a wide variety of sea water samples and those released by red, green, and brown seaweeds indicate that organic S emissions dominate over hydrogen sulfide. It was hypothesized that the micro-biota in the various natural systems like soil, leaf litter, lakes, ponds, rivers and the ocean produce predominantly organic sulfides, and that the reported observation of H_2S emissions from water logged soils and anaerobic muds is related to their low pH. Presumably the biogenic production of gaseous S compounds constitutes a major input in the S cycle. The source of strength and spatial distribution of these sources are unknown.
Source: 1

#231

Rasmussen, R.A. and R.S. Hutton. "Utilization of atmospheric organic volatiles as an energy source by microorganisms in the tropics." Chemosphere, 1(1): 47-50 (January 1972).

The hypothesis that the microbial component and possible certain cryptograms that comprise the phyllosplane and rhizosphere common to leaves, stems, barks, and roots of tropical vegetation are a major sink for the naturally

occurring organic volatiles in the air beneath the canopy of tropical forests is examined and extended to suggest the utilization of hydrocarbons by tropical microbial flora to include organic gases in auto exhaust. Studies on the organic volatiles in tropical rain forests determined a lack of terpene hydrocarbons and a growth-promoting property of the organic-water condensate obtained from the freezeout of forest air for mixed wild types of microorganisms. In conjunction with the hypothesis, gas chromatographic analyses of diluted auto exhaust in temperature cycled chambers simulating optimum growth conditions for tropical microbial ecosystems demonstrated that the differences in the rate of disappearance of hydrocarbons in the chambers were real and were related to the presence and activity of the microbial community of the leaf litter within the chambers.
Source: 1

#94

Rasmussen, R. A., R. S. Hutton, and R. J. Gaines. "Factors in establishing microbial populations on biologically inert surfaces." In: Biodeterioation of Materials. Proceedings of the 1st International Bideterioration Symposium, Southampton,(1968). A. H. Walter & J. J. Eldrick (eds.). pp. 79-98. (1968).

A marked variation was seen in the relationship between the airborne microorganisms found in and above vegetation in a semideciduous forest area at Fort Clayton, Canal Zone, and the extent of microbial contamination collecting on an exposed surface in this environment. The form of variation between calculated and observed relative rates of deposition of airborne forms on surfaces appear to be related to all the environmental factors measured in simple terms of site, time, elevation, and season. Specific elements other than those of climate, such as condensible organic volatiles and aerosols, apparently exert primary influences which interact to provide a proper milieu for a microbial community.

Patterns of organic volatiles were obtained for almost all biological surfaces. The contamination of a clean surface predictably altered the pattern of volatiles coming from that surface. Comparison of the data obtained from controlled atmospheres in small chambers (with and without microorganisms) with the atmosphere beneath the tropical forest canopy suggests that microbiology and chemistry of forest atmospheres is influenced by the heavy canopies of leaves (surfaces).

This interaction of surface, microorganisms, condensible volatile chemicals, aerocolloidal matter, and diffusophoresis was studied to explore and define the effect of trace levels of chemicals in the atmosphere on microorganism growth. The role of these naturally occurring organic volatiles in biological systems is not well defined; but experimental results strongly suggest a fate associated with entrainment with water vapor, condensation and absorption on inert and viable surfaces, and their metabolism by microorganisms. These phenomena may exert a primary ecological influence in establishing a microbial population through the build-up of organic layers by condensation of water vapor and diffusophoretic enrichment of the condensate with organic volatile material found in the atmosphere.

Tests comparing microbial growth on agar plates or inert metal surfaces, with and without the addition of volatile chemicals condensed from the atmosphere and temperature cycling, showed growth stimulation by the chemicals condensed from the air. Results suggest the adjuvant properties of the cold trap products, and also a possible chemical-microbe relation which is not observed by the methods normally used. Possibly a new approach for studying microbial ecology exists in the study of these interacting phenomena.
Source: 7

#926
Rasmussen, K. H., M. Taheri, and R. L. Kabel. "Sources & natural removal processes for some atmospheric pollutants." Center for Air Environmental Studies. Penn St. U., Univ. Pk., Penn. 16802. EPA 650/4-74-032 (June 1974).

This report has attempted to illustrate what the "state of the art" is in the recognition of the various sources and sinks of gaseous pollutants. This information, summarized in Table I, outlines the nature and size of anthropogenic and natural emissions for the various gases (H_2S, SO_2, N_2O, NO, NO_2, NH_3, CO, O_3, and hydrocarbons), along with their ambient background concentrations and a listing of their major sinks identified to date. All information in this table is expanded upon in the text and is supplemented with any quantitative data on removal rates available.

The quantitative information given in this paper has, in most instances, been subject to conversion of units. The conversions were made to attain some consistency among the data and with the International System (SI) of Units. Because many people are not yet acquainted with this system, formerly used concentration dimensions, such as parts per million, are given in parentheses.

The amount of information available on gaseous source and sink strengths has blossomed the last several years. In fact, our knowledge in some areas has increased so much that much of the information in Robinson and Robbins' (1968) original work on trace gases in the atmospheric environment is now outdated. Contrary to belief of just a few years ago, for instance, it is now obvious that natural carbon monoxide emissions play an important role in determining the atmospheric background concentration of this gas.

A comprehensive search for natural pollutant removal mechanisms is presented. The following processes have been identified:

(1) foliar absorption
(2) soil absorption
(3) absorption by natural water bodies
(4) absorption by natural stone
(5) rainout and washout (scavenging), and
(6) chemical reactions in the atmosphere

Quantitative modeling of most of these mechanisms is found to be in its infancy.
Source: 8

#101
Rasmussen, R. A., and F. W. Went. "Volatile organic material of plant origin in the atmosphere." Nat. Acad. Sci. Proc., 53:215-220 (1965).

Using a sensitive gas chromatograph mounted in a mobile trailer laboratory, the presence in air of many organic compounds in molecularly dispersed state can easily be measured. The hydrogen flame detector, which responds only to organic molecules, has a sensitivity of better than $1:10^9$, using 5-cc air samples.

Whereas in cities gasoline and other man-produced organic vapors constitute the bulk of the organic volatiles in the air, in the countryside, away from highways and human activities, plant products predominate. Among these, a- and b-pinene myrcene, and isoprene were identified. Their concentration depends on meteorological conditions and density and activity of plant cover; during summer usually more than 10^{-8} organic volatiles occur in the country or forest air; during winter this decreases to 2×10^{-9}. After one or more dark rainy days plants release less terpene. Upon the death of cells large amounts of terpenes are released explaining the aromaticity of drying hay or of forests during autumn. High concentrations of terpenes in the air were associated with the dying of leaves in autumn, and with the mowing of meadows. A world production for plant volatiles released to the atmosphere is estimated to be 438×10^6 tons per year.
Source: 7

#732
Ratsch, Hilman C. "Sulfur content of Douglas-fir foliage near a paper mill." U.S. Environmental Protection Agency, Office of Research and Development, Washington, U.S. Govt. Print. Off. iii, 13 p. illus (1974). EPA-660/3-74-018.

Douglas-fir needles were collected at eleven sites on the south side of the Columbia River in the vicinity of the Wauna Pulp and Paper Mill. The concentration of total sulfur in the needles ranged from 0.0--0.2 percent at eight locations and 0.5--1.0 percent at three hillside locations. Douglas-fir needles with high sulfur contents at the three hillside locations had no visible sulfur dioxide injury symptoms. The high sulfur values in needles indicate sulfur dioxide is being absorbed by the foliage and are on the borderline level of production visible injury.
Source: 2

#125
Raynor, G. S. "Effects of a forest on particulate dispersion." Proc. USAEC Meteorol. Info Meeting. pp. 581-586. (1967).

Attempted to determine the behavior of the plume as it approached the forest edge as a function of release site and meteorological conditions; to determine the dispersion rate within the forest as compared to the rate over open terrain under similar conditions; and to identify the mechanisms important in the removal of particles from the air within the forest. Results: Plume is broadened horizontally and vertically by divergence of the wind at forest edge; particles tend to penetrate at tree trunk height or to rise above the canopy following previously described wind pattern; loss of particulates occurs mainly in two stages and by two mechanisms, impaction near the forest and deposition well within the forest; total loss of particulates over the distance studied is considerably greater than over open terrain. Results suggested that flow field induced by forest rather than presence of the vegetation itself is primary cause of the dispersion pattern observed.
Source: 7

#1092
Raynor, S. C., and K. P. MacKay. "Bacterial air pollution from an activated sludge tank." Water Air, Soil Poll., 5:47 (1975).

Concentrations of air-borne coliforms and 'other' bacteria (defined as total bacteria minus coliforms) were measured downwind of a sewage treatment plant activiated sludge tank. The Gaussian plume diffusion equation adequately predicts concentrations of the 'other' bacteria; the diffusion equation must be modified by an extinction coefficient, equivalent to a half-life of about 7.4s, to predict coliform concentrations. Coliform concentrations downwind of this tank did not present a significant health hazard, but the method is applicable to treatment plants of higher capacity and possibly greater emissions.
Source: 1

#146
Raynor, G. S., M. E. Smith, I. A. Singer, L. A. Cohen, and J. V. Hayes. "The dispersion of ragweed pollen into a forest." 7th National Conf. Agric. Meterology. Rutgers University, New Brunswick, pp. 1-11 (1966).

A series of dispersion experiments was conducted with ragweed pollen emitted from sources at various distances and at several heights upwind of a forest edge. Concentrations were measured at numerous sampling points both within and above the trees beginning outside of and extending for 100 m into the forest. Deposition measurements were taken at ground level. Most tests involved simultaneous release of differently colored pollen grains from three locations spaced either in the upwind direction or in the vertical, permitting study of the effects of source position with other variables constant.

Both concentration and dosage measurements are presented on XY, XZ, and YZ planes throughout the sampling network. By graphical integration, the flux of pollen through crosswind planes at several distances within the forest is calculated. The loss over successive intervals is compared to measured deposition. Results are also compared to both calculated and experimental dispersion measurements of identical particles, and to calculated measurements of non-sedimenting particles dispersed under similar conditions over open terrain.
Source: 7

#290
Rehman, C. A., R. J. Schoeppel, and J. H. Sherrard. "An impact analysis of natural and man-made factors affecting regional air quality in terms of costs-benefits." Louisville Univ., Speed Scientific School, Ky.; International Assoc. for Pollution Control; American Chemical Society, Washington, D. C.; American Inst. of Chemical Engineers, New York: American Inst. of Industrial Engineers, New York: American Society of Civil Engineers, New York; American Society of Mechanical Engineers, New York; American Water Works Assoc., New York; Inst. of Electrical and Electronic Engineers, New York; and Water Pollution Control Assoc., Environ. Eng. Sci. Conf., Annu. Meet., Louisville, Ky., p. 109-129 (March 4-5, 1974).

Some trade offs between the benefits of pollution control and the costs are necessary. In order to arrive at these trade offs intelligently, the following questions must be answered: given the economic conditions, what level of air pollution is acceptable; what should be done to achieve this optimum level; and how can costs be fairly passed on to those persons who contribute to pollution? Each of these questions is discussed. A rational procedure is given for estimating a series of the most probable costs that could be passed on to the polluters depending upon their relative contributions to the deterioration of the community air. The approach tends to pinpoint what decisions must be taken by management to avoid future mishaps in the community under study. The approach provides a rational setting where a community can select how much pollution it can afford by now allowing enough money to combat pollution. By assessing the unfair damages that are unknowingly caused through accidents, the approach provides a factual basis to provide renumerations to those who are affected by pollution. A detailed classification of sources of pollution and factors of emission associated with each of the sources is also given.
Source: 1

#1199

Reimschussel, E. F. "A pollution solution - plant trees." Brigham Young Univ., Provo, Utah. Western Chapter. Int'l. Shade Tree Conference. Pasadena (May 12, 1970).

Planting trees helps reduce noise, dust, heat, and improves the asthetic value of the area. General observations are made: SO_2 injury is increased by light, heat, and moist air; conifers are generally susceptible; most decidious trees are moderatly susceptible; while maple and yew are very resistant to SO_2. Effects of different pollutants differ from plant to plant. Rate of pollutant removal depends upon pollutant concentration; the greater the concentration, the more enters the stomates, and there is more removal. Planting forests results in a net increase of O_2 in the atmosphere.
Source: 8

#535

Reinert, R. A. "The use of plants for the detection of air pollution." In: Northwest Workshop Air Pollution and How It Affects Plants. p. 118-128 (1973).

The purpose of this paper is twofold: (1) to discuss terminology and the use of plant indicators, plant monitors, field surveys, field studies. and bioassay techniques in diagnosing air pollution injury and damage to economic crops and vegetation; and (2) to discuss some of the past and present research that hopefully will lead to a better understanding of the use of plants in the diagnosis of air pollution effects.
Source: 2

#1682
Reinert, R.A., A.S. Heagle, J.R. Miller, and W.R. Geckeler. "Field studies of air pollution injury to vegetation in Cincinnati, Ohio." Plant Disease Reptr., 54(1):8-11 (Jan 1970).

The plant injury attributed to air pollution in Cincinnati and air quality with respect to ozone, nitrogen dioxide, and sulfur dioxide were correlated based on data collected in a field study. Plant damage was investigated for petunia, bean, radish, squash, tomato, alfalfa, oats, and tobacco plants, grown in unfiltered air chambers and compared with control groups grown in charcoal-filtered-air chambers. The symptoms included tissue damage and early senescence and were characterized by flecking, chlorosis, necrosis, stippling, bleaching, and mottling. Acute injury was related to high ozone levels, and the symptoms were usually similar to those resulting from experimental exposure to ozone.
Source: 1

#1683
Reinert, Richard A. and Harvey W. Spurr, Jr. "Differential effect on fungicides on ozone injury and brown spot disease of tobacco." J. Environ. Quality, 1(4):450-452 (Oct-Dec 1972).

The differential effects of fungicidal applications on the incidence of ozone injury and brown spot disease on tobacco leaves were investigated. The protective qualities of maneb, dodne, and benomyl were studied. All of the fungicidal applications decreased ozone injury to tobacco leaves. Benomyl was most effective, decreasing leaf injury by 59%. Maneb significantly decreased brown spot injury by 66%, and benomyl and dodine decreased injury by lesser degrees.
Source: 1

#661
Reinert, Richard A., David T. Tingey, and Hershell B. Carter. "Sensitivity of tomato cultivars to ozone." Agricultural Research Service, Raleigh , N.C., Plant Science Research Div. and Environmental Protection Agency, Raleigh, N.C., Div. of Effects Research, 15 p. (1972).

Twelve cultivars of tomato were exposed to a 40 pphm ozone for 1.5 hrs. in separate morning and afternoon exposures to determine differences in cultivar sensitivity. Nearly all of the cultivars exposed in the afternoon developed more injury than similar cultivars exposed in the morning. Cultivar ranking, however, was the same in morning and afternoon exposures. Ozone injury symptoms were similar among the various tomato cultivars. The recently matured leaves of the plant were more sensitive to ozone than the younger immature leaves, and frequently the terminal leaflet of the five leaflets comprising the tomato leaf was injured first. Symptoms varied from a chlorotic mottle or spotting to an upper surface necrotic fleck. A bifacial necrosis which was usually interveinal developed as the injury seventy increased. Occassionally, upper surface fleck tended to form primarily along secondary and tertiary veins. Roma VF and Red Cherry were among the most sensitive cultivars tested and Heinz 1439 and VF 145B were the least sensitive of the 12 tomato cultivars tested.
Source: 1

#660

Reinert, Richard A., David T. Tingey, and Hershell B. Carter. "Sensitivity of tomato cultivars to ozone." J. Amer. Soc. Hort. Sci., 97(2):149-151 (March 1972).

Twelve cultivars of tomato were exposed to 40 pphm ozone for 1.5 hr in separate morning and afternoon exposures to determine differences in cultivar sensitivity. Nearly all of the cultivars exposed in the afternoon developed more injury than similar cultivars exposed in the morning. Symptoms varied from a chlorotic mottle or spotting to an upper surface necrotic fleck. A bifacial necrosis developed as the injury severity increased. Cultivar ranking, however, was the same for morning and afternoon exposures. Roma VF and Red Cherry were the most sensitive and Heinz 1439 and VF 145B were the least sensitive of the cultivars tested.
Source: 1

#858

Reinhard, H. "Die Fluorschaden im unteren Frichtal." (Fluorine damage in the lower Frick Valley). Schweiz Arch. Tierheilk, 101(1):1-4,(1959).

Even though the only aluminum produced in Germany today is manufactured by an electrolytic method, fluorine emissions are still 500 kg per day. In the area of one plant, the quantity of fluorine sedimented per acre in 1956 amounted to approximately 7 kg at 300 m from the plant, decreased rapidly to 0.9 kg at 700 m, and then decreased slowly with increasing distance. Severe clinical phenomena have been observed on vegetation at quite distant locations and can be attributed only to airborne fluorine. Moreover, feed plants (hay and grass) have been damaged, even when their fluorine levels were below those considered toxic by most authors.
Source: 1

#353

Reisch, K.W. and G.E. Hull. "The role of trees in the environment." Ohio Rep., 55:72-73 (1970).

Trees serve as positive factors in the reduction of air pollution. They serve as filters in that, as polluted air passes around their leaves, it is diluted by the oxygenated air. Solid pollutants in the air are absorbed on the surfaces of leaves and stems and are washed to the ground during rainfall. Solids are also precipitated from the air as turbulence is reduced when air passes under and through the trees. Trees are also detrimentally affected by pollutants and the unnatural environment often found in urban and suburban situations. Because of the increased emphasis on the ornamental planting of trees in cities and on streets and highways, the adaptability of various species to specific conditions is under study. The Ohio Agricultural Research and Development Center has undertaken a two-phase study to determine the suitability of various species for various landscapes and to determine their ability to thrive under various conditions.
Source: 1

#232
Rentschler, I. "Die Bedeutung der Wachsstrukturauf den Blaettern fuer die Empfindlichkeft der Pflanzen gegenueber Luftverunreinigungen." (The significance of the wax structure on leaves concerning the susceptibility of the plants to air pollutants). Text in German. Proc. Int. Clean Air Congr., 3rd, Dusseldorf, West Germany, p. A139-A142, (1973).

Studies on the relationships between the presence and structure of wax coating on leaves and plant susceptibility to air pollutants are reviewed. Plants with wettable leaves without wax coating are more susceptible to air pollutants than such with wax-coated leaves. Leaves without wax coating adsorb particulate matter readily, wiich very often leads to the stomat, becoming clogged. The absorbed pollutants can be rarely washed off. Young leaves with amorphous wax coats are most resistant to air pollutants. Particulate matter settled on leaves with a hydrophobic wax coat is readily washed off by rain. The leaves may lose part or all of their wax coats during the vegetation period. Plants with wax-coated leaves on which the wax coat does not deteriorate during the vegetation period, and also covers the stomata are most resistant to air pollution. Since the development and the nature of the wax coating is dependent on both the humid ity and the air temperature, the local climatic conditons influence the susceptibility of the plants to air pollution.
Source: 1

#964
Renzetti, N. A., and G. J. Doyle. "Photochemical aerosol formation in sulfur dioxide - hydrocarbon systems." Int. J. Air Water Poll., 2:327-345 (1960).

We have conducted a series of photochemical experiments in a 50-l. stirred-flow reactor to study aerosol formation from different hydrocarbons in the presence of nitrogen oxides and sulfur dioxide.

Irradiation by simulate sunlight of trace concentrations (p.p.m.) of the reactants, in some cases, yielded particles in the size regime 0.1-0.3 μ diameter, which by scattering of light are important to visibility in the atmosphere. A large number of experiments with 3 p.p.m. of various hydrocarbons, 1 p.p.m. nitrogen oxides, and 0-1 to 0.5 p.p.m. SO_2 indicated that the olefinic hydrocarbons were the only important aerosol formers in contrast to the paraffinic and aromatic hydrocarbons. It was observed that the photolysis of sulfur dioxide proceeds at the rate of 0.4 per cent per minute which is considerably above that observed by Johnstone and Gerhard (1955). The high sulfate content of the particulate matter and low gaseous sulfur dioxide concentrations observed in the Los Angeles smog are consistent with the findings of this laboratory program.
Source: 5

#1684

Reusmann, G. and J. Westphalen. "Automatische Bestimmung von Blei, Zink, Cadmium und Kupfer in Pflanzenmaterial durch Inversvoltammetrie." (Automatic determination of lead, zinc, cadmium and copper in plant materials by stripping voltammetry). Z. Anal. Chem., 264(2):165-167 (1973).

During the automatic determination of lead, zinc, cadmium, and fluoride in plants by stripping voltammetry, the plant material is fused with sodium hydroxide. Afterwards hydrochloric acid and citric acid is added, and a pH value of 3.7 is adjusted. For the determination of copper, the samples were acidified with perchloric and citric acid. Then a pH value of 2.7 is adjusted. It is possible to carry out several determinations of lead in plant materials with only one drop of mercury. The limit of detection is 1.3 ppm.
Source: 1

#532

Rhoads, A.F., and E. Brennan. "Air pollution effects studies." Am. Christmas Tree J. 18(1):25-28 (Feb. 1974).

There is an urgent need for research on acute air pollution as well as the more subtle effects. Photochemical pollutants are the biggest problem, and both ponderosa pine, and eastern white pine, are highly susceptible to these pollutants. A New Jersey study has begun to find the effects of air pollution on trees in a metropolis. Tree damage is described. Damages on conifers will vary in severity from year to year. Also, environmental conditions affect the degree to which plants will be damaged.
Source: 2

#733

Rhoads, A.F., and E. Brennan. "Fluoride damage to woody vegetation in New Jersey in 1974. Plant Dis. Rep., 59(5):427-429 (May 1975).

In the course of a 2-year survey to assess the impact of air pollution on trees in New Jersey, we documented two incidents of severe damage to woody plants by fluorides emitted from specific industrial sources. We observed classic fluoride toxicity symptoms on plant species that are generally regarded as sensitive, and also on several species of oak. The symptom on pine was unusual in that a dark band delimiting the necrotic area on the needle appeared 3-4 weeks after the initial injury occurred. Douglas-fir and peach trees that were defoliated by the pollutant put out a second flush of growth. Among the species exhibiting extreme resistance to fluoride damage were American holly, white birch, London plane, flowering dogwood, magnolia, mulberry, apple and Norway apple.
Source: 2

#109

Rich, S. "Plants as air purifiers." Frontiers of Plant Science (Conn. Ag. Exp. Sta.), 21:6-7 (1968).

Plants provide O_2, remove CO_2 and harmful gaseous air pollutants, even, in the latter case, to the detriment of the plant. This ability is an important reason to preserve greenbelts in our cities and towns. Bacteria may remove CO from the atmosphere. Suggests debt of man to tiny, unseen myriad of plants - bacteria and phytoplankton (large source of O_2).
Source: 7, 6

#1127

Rich, S. "Effects of trees and forests in reducing air pollution." University of Mass., Amherst. In: Trees and Forests in an Urbanizing Environment, Coop. Ext. Serv. Plan. Resour. Dev. Ser. No. 17. p. 29-33 (1970).

For protection of our environment, we must increase forest lands, with proper management and preservation of the product. Review of an experiment is made in order to answer the question concerning the rapidity for which ozone is removed, by plants, from the atmosphere. Results indicate plants appreciably reduce ozone in polluted air. Graphs demonstrate this. SO_2 can be removed from the air by foliage w/o having to penetrate leaves. CO_2 content of the atmosphere is increasing at an annual rate of .25%, and we can't expect present forests to keep up with the present output of CO_2. For best results, conifers should be grown rather than decidious trees.
Source: 8

#122

Rich, S., and H. Tomlinson. "How plants trap ozone." Frontiers of Plant Science, 20(2):4-5 (May 1970).

By conducting experiments in an environmentally controlled chamber it was determined that the rate of ozone removal by bean leaves is regulated primarily by size of stomatal opening. Subsequent lab and computer analysis showed that plants can remove enough O_3 from the air to benefit the environment, i. e., if a mass of polluted air containing 150 ppb O_3 stood over a forest of trees 50' tall for 1 hr., the air filtering down to the floor would have 60-90 ppb O_3 remaining. The rest would have been absorbed by the canopy of leaves.
Source: 6, 7

#582

Rich, Saul and Neil C. Turner. "Effect of ozone on stomatal behavior of water-stressed and unstressed plants." Presented at the Air Pollution Control Association, Annual Meeting, 64th, Atlantic City, N.J. 71-63 (June 27 - July 2, 1971).

A porometer was used to measure the stomatal resistance of water-stressed pinto bean and tobacco plants when exposed to ozone. The beans were water-stressed either by withholding water from the soil or by exposing the plants at low relative humidity. Two varieties of tobacco were compared, one resistant to ozone and the other susceptible. The tobacco was water-stressed by exposure at low relative humidity. When exposed to ozone, stomata of water-stressed plants tend to close readily, while those of unstressed plants close slowly if at all. With tobacco exposed to ozone in a dry atmosphere, the stomata of the ozone-resistant variety close more quickly and to a higher resistance and open more slowly than those of the ozone-susceptible variety. Ozone would be scrubbed from the air most efficiently by well-watered plants that are not injured to ozone even when their stomata are open. Plants susceptible to ozone injury could be made more resistant by subjecting them to water stress during periods of air pollution.
Source: 1

#381
Rich, S., P. E. Waggoner, and H. Tomlinson. "Ozone uptake by bean leaves." Science, 169(3940):79-80 (July 3,1970).

The ozone uptake by bean leaves was measured; the data obtained were converted to resistance to ozone, and the resistance was compared to water vapor loss. The rate of ozone removal was measured as the time required for the concentration to decline from 200 to 150 ppb within a closed, illuminated, 75-liter chamber equipped with a fan. The observed removal of ozone by a particular leaf was proportional to leaf area, and inversely proportional to chamber volume. Several equations for the rate of ozone depletion are given. The stomata were primarily involved in controlling ozone uptake. When observations were taken as the stomata opened or closed, the resistances measured by promoter or by ozone uptake were very similar. The near equality of the resistances indicates that ozone and water vapor level travel the same path, but in opposite directions. The equality also implies that ozone is reduced to a low concentration at surfaces of the substomatal cells. The close relationship between the factors regulating ozone uptake and transpiration help explain the fact that the degree of ozone injury to tobacco could be correlated with ambient concentrations of ozone only when adjustments were made for the ratio of transpiration to atmospheric water demand. This adjustment is seen as an index of stomatal opening and a confirmation of the stomatal control of ozone uptake.
Source: 1

#859
Richardson, D.H.S., and K.J. Puckett. "Sulphur Dioxide and Photosynthesis in Lichens." In: Air Pollution and Lichens. B.W. Ferry, M.S. Baddeley, and D.L. Hawksworth (eds.), Toronto, Toronto Univ Press., Chapt. 13, p. 283-298 (1973).

The effects of sulfur dioxide on photosynthesis in lichens are reviewed. There may be a temporary and partial inhibition of photosynthesis in the presence of low concentrations of SO_2. Several chronic fumigations may interfere with the flow of nutrients, such as carbohydrates, between the symbionts resulting in the breakdown of the symbiosis. The disappearance of lichens from industrial areas with low prevailing SO_2 concentrations may be explained by effects on the physiology of the symbiosis. The action of SO_2 on photosynthesis depends on the intensity of fumigation and ranges from a temporary inhibition of photosynthesis to a permanent reduction associated with chlorophyll breakdown. Sulfur dioxide is less toxic when buffered in high pH. The pH determines the proportion of the different ionic species (sulfurous acid, bisulfite, sulfite) in aqueous solutions. The increased toxicity of SO_2 to lichens observed at low pH (3.2-4.4) is associated in part with the destruction of chlorophyll by an irreversible oxidation process.
Source: 1

#233

Richter, O. "Pflanzenwachstum und laboratoriumsluft." [Plant growth and laboratory atmosphere]. Ber. Deut. Botan. Ges., (Berlin), 21:180-194 (1903).

A series of experiments designed to determine the effect of reduced oxygen or increased carbon monoxide on plant growth is described. The results of the experiments indicate that gaseous impurities in the atmosphere may have significant effects on the rate of plant growth. Another series of experiments is conducted to determine the specific effects of coal gas, particularly acetylene and ethylene, on the growth of certain vegetables. The results indicate that coal gas has an inhibiting effect on the growth in length and that it promotes the growth in thickness. A simple gas absorption system utilizing charcoal decreases the influence of coal gas. The shortening and thickening of affected plants is proportional to the amount of coal gas and to the duration of exposure. The effects of reduced oxygen partial pressure and plant respiration on plant growth include nutations of 130-270 deg. Mercury vapor can produce similar differences in growth as coal gas; however, it kills the plants within a short time.
Source: 1

#1685

Ricks, G. R and R.J.H. Williams. "Effects of atmospheric pollution on deciduous woodland. Part 2: Effects of particulate matter upon stomotal diffusion resistance in leaves of Quercus petraea (mattuschka) leibl." Environ Pollut., 6(2):87-109,(Feb. 1974).

Stomatal diffusion resistance of leaves of Quercus petraea (oak leaves) in an area of deciduous woodland subjected to a differential gradient of particulate pollution was measured. Accumulation of particles on the lower surfaces of leaves interfered with normal stomatal behavior and, as a result, maximal diffusion resistance measured at night was considerably lower than that measured at an unpolluted rural site. The magnitude of the reduction in the maximal diffusion resistance at night was related to the proportion of stomata that had their pores partially occluded by particles. The effects upon gas exchange in the leaves were also examined. Overall rates of water loss were not seriously increased by the reduction in diffusion resistance at night, but uptake of gases such as sulfur dioxide was enhanced.
Source: 1

#135
Ripparton, T. A. "The effect of water vapor on ozone synthesis in the photo-oxidation of alpha-pinene." J. Air Pollut. Control Assoc., 21(10):629-635 (1971).

A study of the effect of water vapor on the photochemical system NO_2 + alpha-pinene + Hv was conducted. A Hotpack Environmental Room was used as a constant temperature chamber, a bank of ultraviolet and fluorescent lamps as a source of simulated solar radiation, and a 150-liter FEP Teflon bag as a reaction vessel. Representative concentrations of 10 pphm NO_2 and 50 pphm alpha-pinene were used in a 3 x 2 x 2 factorial design where absolute humidities of 0.0000, 0.0090, 0.0180 g H_2O/g dry air were varied.

Matheson zero air was passed through a clean air train and used as the diluent. Nitrogen dioxide was added to the reaction mixture by a permeation tube, and water and alpha-pinene by evaporation techniques.

Variables measured as a function of time over a 2-hour irradiation period were total oxidants (Mast Ozone Meter), condensation nuclei (General Electric Small Particle Detector), ozone (Regener Chemiluminescent Ozone Meter), nitrogen dioxide and nitric oxide (Technicon Autoanalyzer), and alpha-pinene (Perkin-Elmer Model 800 gas chromatograph).

Upon irradiation, systems containing nitrogen dioxide and alpha-pinene formed oxidants, ozone, condensation nuclei, and nitric oxide. Based on the differences between simultaneous oxidant and ozone measurements, the formation of peroxide-like compounds may be inferred. During the course of the irradiation, nitrogen dioxide and alpha-pinene were consumed. The concentration-time profiles of all variables were characteristic of those exhibited by typical photochemical smog systems.

An effect of water vapor on the systems studied was demonstrated. Increasing humidity decreased net mean/time oxidant and ozone production and net maximum condensation nuclei production. These effects were significant at a 0.05 confidence level. Effects of water on average mean/time NO_2, NO, and alpha-pinene concentrations were insignificant at this level. The oxidant to ozone ratio was found to decrease with increasing humidity.

The significant decreases in net oxidant and ozone production and NO_2 consumption with increasing water vapor concentration in systems of nitrogen dioxide alone, suggests that water manifests an effect on pertinent inorganic reactions, and the data also suggest additional water participation in the organic reactions.
Source: 7

#354
Rippel, A. "Long term effect of fluoride emissions upon vegetation." Fluoride Quarterly, J. Intern. Soc. Fluoride Res., 3(1):18-21 (Jan. 1970).

The results are presented of an eight year study of the fluoride content fruit, vegetables, and grain grown in four communities near a Czechoslovak aluminum factory. In the community nearest the factory, the fluoride levels

in fruit and grain were five and six times higher, respectively, than those of controls. However, the fluoride levels in grain were only 2.6 times as high as in the controls. Root vegetables, especially potatoes, exhibited only minor changes in fluoride content, suggesting that fluoride uptake by plants is independent of fluoride levels in soil. In tuberous vegetables, fluoride accumulated in the portions of the plants growing above ground rather than in the tubers. This fact points to fluoride uptake from the air. The fluoride levels observed after the long term exposure of plants were above normal. Fruit trees deteriorated progressively, particularly the sensitive plum trees and grape vines. The long term emissions also distinctly decreased the biological and organoleptic values of the agricultural product and the productivity of agricultural plants.
Source: 1

#662
Rippel, A. "Fluoride intake from food." (Presented at the International Society for Fluoride Research, Annual Conference, 4th, the Hague, Netherlands, Oct. 24-27, 1971) Fluoride, 5(2):89-91 (April 28 1972).

In order to evaluate the safety of food grown near a Czechoslovakian aluminum smelter, grain and vegetables were assayed for their fluoride content at varying distances from the smelter during a 10 year period. The fluoride content of green parsley leaves was 11.57 ppm (control 0.66); the roots contained 0.08 ppm (control 0.03) and the outer surface of root contained 0.08 ppm (control 0.03). Relatively little fluoride was found in potatoes. At a distance of 80-130 m in the area of the prevailing winds, the fluoride content of the grain varied within 6.34-19.64 mg/kg. At a distance of 500 m, the fluoride levels of grain were reduced to about 35% and at 1 km to about 15% of these values. Grain cultivated in a circular area with a diameter of 2 kilometers from the source of emission should not be consumed locally but can be exported for use to uncontaminated areas, and fluoride should not be added to drinking water in the vicinity of a fluoride-emitting factory.
Source: 1

#860
Rippel, A. and J. Janovicova. "Der Einfluss von Fluorexhalaten auf die Pflanzenwelt in der Umgebung eines Aluminumwerkes." (The influence of fluorine exhalation on the flora in the surroundings of an aluminum plant). Air Pollution Proc., First European Congr. Influence Air Pollution Plants Animals, Wageningen, 173-178 (1968).

Examination of the forest vegetation and agricultural life in the surroundings of an aluminum plant over a period of six years revealed intoxication and injuries to the vegetation by fluorine compounds. The degree of injury differed in correlation with the distance from the plant and the prevailing wind direction. Further studies revealed that plums were a more sensitive indicator to fluorine pollution than apples, pears, cherries, and grapes. Among vegetables the most striking differences were noted with leaf vegetables such as lettuce and cabbage. Wheat showed higher fluorine contents than rye.
Source: 1

#1687

Robak, H. "Aluminum plants and conifers in Norway." Council of Europe, Committee of Experts on Air Pollution, Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, 27-31 (1968).

Quantities of fluorine emitted from aluminum plants polluting the air in Norway vary from 8-10 to 27-30 kg/hr. Natural pine forests in the neighborhood of all plants are notably damaged, in three cases even completely destroyed. Visible injury is observable at up to 32 km. The current year's needles of badly damaged trees usually show a fluorine content above 40 ppm. Damage to spruce forests has occurred in a 100-200 ha area within which the fluorine content of the current year's needles exceeds 15-20 ppm and that of the last year's needles 24-35 ppm. Because the outlook for preventing fluorine-induced conifer damage by technical means does not appear promising, a switch should be made to more resistant conifer species. Field observations and experimental plot studies show that Larix decidua and L. leptolepis are remarkably free from damage, even under unfavorable weather conditions.
Source: 1

#1686

Robak, Hakon. "Probleme und Aufgaben der Diagnostik der durch Luftverusreinigung verursachten Waldschaeden." (Problems and tasks of diagnosis of forest injuries caused by air pollution). Presented at the International Union Forest Research Organization Congress, Sopron, Hungary (Oct. 9-14, 1972).

The tasks of diagnosing injuries from air pollution involve the determination of whether the observed injury does indeed stem from air pollution and which emission component caused the injury. The problems of diagnosis are manifold due to the different reactions of the plants to the various pollutants or to the absence of reactions. A brief review of direct and indirect effects of air pollutants is given. In cases of very mixed pollution coming from many different sources, the decisive factors can be determined only through greenhouse exposure experiments. Leaf and needle analyses are valuable tools for diagnosis. Anatomic criteria, growth retardation, and harvest losses are not specific enough. Aerial photography also lacks specificity. Doubts still exist concerning the specific sensitivity of indicator plants. Some experts place the Medicago sativa plant among the sulfur dioxide indicator plants claiming that this plant is rather resistant to fluorine, while others group it with the fluorine indicator plants on the grounds that this plant reacts to very small concentrations of fluorine with minor visible injuries. Widespread agreement seems to exist that belies are particularly sensitive for fluorine, papilionacae for SO2. Lichens and mosses are obviously indicators of the general air pollution. The problem of injuries by indirect emissions which may spread over thousands of kilometers are discussed. For instance, sulfuric acid formed through oxidation of SO2 and subsequent water intake renders strongly acid precipitation which particularly affects soils with a weak buffering capacity, and eventually all vegetation growing in such soils.
Source: 1

#963

Robert, J.J., E.S. Croke and A.S. Kennedy. "An urban atmospheric dispersion model." Proc. Symp. on Multi-Source Urban Diffusion Models. EPA. EP4.9:86, (1970).

A computerized, multiple-source, atmospheric dispersion model has been formulated and programmed for the IBM 360-75 system. This "integrated puff" model provides a more realistic physical simulation of the processes of smoke plume dispersion than has hitherto been employed, since it provides for simulation of near-zero wind speed conditions, models three-dimensional wind vector variation and atmospheric diffusion, including upwind-downwind diffusion, and permits variation of stability and mixing layer depth with time.

A source-oriented model is essential for the development of optimal incident control strategies and long-range abatement plans. For example, a preliminary version of the integrated puff model was programmed and subsequently employed to develop a prototype optimal control model for an urban power plant network. That prototype model will be used in combination with Chicago's emission inventory data as the primary analytical tool in the performance of a series of air pollution system-analysis studies including: (1) Cost-effectiveness analysis of alternative control strategies for specific source-aggregates such as power plants, the food processing industry, the steel industry, asphalt batching, etc.; (2) Development of rapid-response, automated optimal incident control strategies for the urban power plant network, optimal gas allocation to dual fuel sources, process emission control, etc. based on operations research techniques; (3) Development of long-range air pollution abatement plans oriented around the computer simulation of the city, with projections of its population, fuel use, production and transportation network growth patterns, so that emission control legislation, zoning ordinances, etc. can be tested on a simulation of Chicago urban area of the future, and cost-effectiveness studies can be performed to evaluate the economic impact of pollution abatement measures.

The model described in this paper has several aspects in common with earlier efforts: (1) An emission inventory is developed, large emitters are considered as point-sources and smaller residential commercial and industrial emitters homogenized as area-sources on a standard grid; (2) A mathematical algorithm (typically based on the representation of turbulent diffusion by a Gaussian distribution) is used to describe the advection and diffusion of plumes from each of the sources or source areas; (3) Contributions from individual plumes are summed and sometimes integrated over time to give pollution doses at arbitrary locations; (4) The model is validated by statistical comparison with field measurements taken by an array of monitors; and (5) While the results of the validation study may indicate a refinement of certain physical assumptions (such as the plume rise formulation) or inclusion of additional sources (such as distant power plants), no further improvement by linear regression or similar curve fitting techniques is permitted; that is, the model is not tuned to a particular receptor or city. This last point is particularly important if the model is to be used in the development of incident control strategies and long-range urban planning. The essence of an air pollution dispersion model as a collection of algorithms, a set of assumptions and subsequent calculations for every stage of the analysis, from the compilation of the emission inventory to the validation of the results, is discussed briefly in the following sections.
Source: 5, 7

#1189

Roberts B.R. "Environmental stresses on urban trees." Arborist's, 35(4): 33-37 (April 1970).

The author mentions three stress factors which are important in growth and establishment of trees in an urban environment. As stresses increase, these factors will increase in importance. It is imperative that we consider research in the following areas: (1) The overall effect of water on growth of urban trees; (2) The range of soil moisture available for growth for different species; (3) How individual growth characteristics respond to other than optimum amounts of water; (4) Controlling absorption and loss of water through the use of chemicals (this would include studies on mode of action as well as effects on plant growth); (5) The mechanism(s) involved in temperature, moisture, and aeration tolerance; establishment of tolerance levels for important urban tree species; and (6) The physiological response to stress factors.
Source: 6

#515

Roberts, B. R. "Foliar absorption of gaseous air pollutants." Amer. Nurseryman, 133(10):9, 44 (May 15, 1971).

Discusses evidence that plants act as a sink for airborne contaminants. The fact that plants are damaged by pollution and that metabolic processes are interfered with suggests that they are absorbing pollutants. Comments of various European studies are made, on SO_2 deposition and distribution within the plant. In the U. S., an experiment on ozone uptake by bean leaves is discussed. There was a close relationship between stomatal opening and O_3 depletion, and the conclusion reached is that bean leaves effectively absorb ozone from the atmosphere and absorption is regulated by the same factors that regulate stomatal opening.
Source: 2, 6

#1187

Roberts, B. R. "Trees as air purifiers." Plant Science Research Division, Agric. Research Service, U. S. D. A., Delaware, Ohio. Proc. 47th Int. Shade Tree Conf., pp. 23a-25a (1971).

Trees as air purifiers are discussed. SO_2 sorption in woody plants have been investigated by various scientists and Roberts reviews some of the published studies. He also cites several authors that carried out sorption studies on herbaceous plants.
Source: 6

#129
Roberts, B. R. "Absorption of gaseous pollutants by individual leaves: sulfur dioxide." Phytopathology, 64(5):585 (May 1974).

Absorption of gaseous pollutants by individual leaves: sulfur dioxide. B. R. Roberts, (ARS, USDA, Delaware, Ohio).

Foliar uptake of sulfur dioxide (SO_2) was measured in an open fumigation system at 1.0 ppm. Container-grown seedlings of white birch (Betula papyrifera); red maple (Acer rubrum); white ash (Fraxinus americana); sweetgum (Liquidambar styraciflua); rosebay rhododendron (Rhododendron maximum); kurkume azalea (Rhododendron obtusum japonicurr 'Venus'); privet (Ligustrum vulgare); and firethorn (Pyracantha angustifolia) were used in this study. Maple, birch, and sweetgum showed appreciably greater vegetal uptake of SO_2 on a unit area or unit weight basis than did comparable species of rhododendron, ash, and azalea. Privet and firethorn showed an intermediate response. Under controlled environmental conditions, depletion of SO_2 by foliage of firethorn remained relatively constant for periods up to 6 h. There was no significant difference in the capacity of foliage from white ash and azalea to remove SO_2 from the air at pollutant concns of 1.0, 0.5, and 0.2 ppm. However, leaves of birch and firethorn showed significantly less SO_2 uptake at 0.2 ppm compared with uptake at higher concns.
Source: 7

#127
Roberts, B. R. "Foliar sorption of atmospheric SO_2 by woody plants." Env. Pollut., 7(2):133-141 (1974).

Foliar uptake of ambient sulphur dioxide (1.0 ppm) was measured in an open-fumigation system. Container-grown seedlings of white birch (Betula papyrifera Marsh.), red maple (Acer rubrum L.), white ash (Fraxinus americana L.), sweetgum (Liquidambar styraciflua L.), rosebay rhododendron (Rhododendron maximum L.), kurume azalea (Rhododendron obtusum japonicum Wils. cv. Venus), privet (Ligustrum vulgare L.), and firethorn (Pyracantha angustifolia (Franch.) Schneid.) were used in the study. Maple, birch and sweetgum showed appreciably greater vegetal sorption of sulphur dioxide on a unit area or unit weight basis than did comparable species of rhododendron, ash, and azalea. Privet and firethorn showed an intermediate response. Under controlled environmental conditions, depletion of sulphur dioxide by foliage of firethorn remained relatively constant for periods up to 6 h. There was no significant difference in the capacity of foliage from white ash and azalea to remove sulphur dioxide from the air at pollutant concentrations of 1.0, 0.5 and 0.2 ppm. However, leaves of birch and firethorn showed significantly less SO_2 uptake at 0.2 ppm compared with uptake at the higher concentrations. The data show that foliage of certain woody plants may significantly reduce ambient sulphur dioxide levels in the microenvironment immediately surrounding individual leaves.
Source: 1, 6, 7

#1188
Roberts, B. R. "The influence of SO2 concentration on growth of potted white birch and pin oak seedlings in the field." Jour. Amer. Soc. Hort. Sci., 100(6):640-642 (1975).

Potted seedlings of white birch (Betula papyrifera Marsh) and pin oak (Quercus palustris Muenchh) were grown in the field for 3 months in relatively high and low ambient sulfur dioxide air. Biweekly throughout the growing season, plants from each site were harvested, and height and leaf, stem, and root dry weight were measured. The overall growth of white birch, an SO_2 sensitive species, was found to be greater in the higher, but subphytotoxic SO2 environment. Conversely, the growth of pin oak, an SO2 tolerant species, was greater at the low SO_2 site.
Source: 6

#1972
Roberts, B. R., and C. R. Krause. "Changes in ambient SO_2 by rhododendron and Pyracantha." Hortscience, 11(2):111-112 (April 1976).

The capacity of rhododendron (Rhododendron catawhiense Michx., cv. Nova Zembla) and firethorn (Pyracantha coccinea M. J. Roem. var. Lalandii (Duren) Dipp.) to change ambient SO_2 levels in a closed fumigation system was studied. P. coccinea removed greater quantities of SO_2 at faster rates than R. catawhiense. Differences in leaf surface characteristics between the 2 species suggest that at least part of the SO_2 uptake mechanism may involve a surface-mediated response to the pollutant.
Source: 6

#348
Roberts, B.R. and A.M. Townsend. "What role do trees play in cleansing the air?" Weeds, Trees, Turf, 14(7):38-39 (July 1975).

One detrimental side-effect of the increasing energy demand in this country is the possibility of higher levels of air pollution. With more and more industries converting to coal as an alternative source of energy, the concentration of certain atmospheric pollutants, particularly sulfur dioxide (SO2), will increase proportionately. Thus, despite our efforts now and in the future, a certain degree of air pollution is inevitable. The problem then becomes one of maintaining pollution at some acceptable level. This can be accomplished in two ways: (1) by controlling the source of pollution through proper legislation and surveillance; and (2) by maintaining an adequate and effective reservoir for existing pollutants. Much has been said and written about the former approach; this short paper discusses it.
Source: 2

#1117
Robinette, G. "Plants as air conditioners." Horticulture, 46(3):26-29 (March 1968).

Plants do remove from the air impurities such as fly ash, sand, dirt, dust, pollen, smoke, odors and fumes. The method or mechanism by which this is done is divided into six categories: (1) dillution (2) precipitation or filtration (3) narcosis (4) oxidation (5) air washing (6) deodorization or masking. The author describes these techniques with the aid of several drawings.
Source: 6, 1, 8

#355
Robinette, G. O. "Plants/people/and environmental quality." American Society of Landscape Architects Foundation, Washington, D. C. 152 p. (1972).

The ecological and sociological value of plants is reviewed in terms of their functional, architectural, engineering,climatological, and esthetic uses. Oxygenation and dilution are two mechanisms by which plants control air-polluting gases. Particulates are trapped by plants for subsequent washing to the ground. Plants also have the ability to absorb odors directly and metabolize them. Computer modeling studies indicate that 150 ppb of ozone can be reduced by a forest over an 8 hr. period to a forest floor level of only 30 ppb. Dust concentrations may range from 10,000 to 12,000 dust particles per liter on streets without trees as compared to 1000 to 3000 dust particles per liter for streets with trees.
Source: 1, 8

#1190
Robinette, G. "Trees --- green air conditioners." (journal unknown) pp.16-18, 22.

Plants serve to condition and cleanse air. Vegetation, as air conditioners, control temperature, airflow, and moisture content. Also, plants remove air impurities such as dust, smoke, pollen. There are six basic methods that plants can clean air: dilution, precipitation or filtration, narcosis, oxidation, air washing, reodorization or masking. The effect of plants as air conditioners is discussed as well as the dust-reducing effect of plants.
Source: 6

#962
Robinson, E. and C.E. Moser. "Global gaseous pollutant emissions and removal mechanisms." Proceedings of the Second International Clean Air Congress, H.M. Englund & W.T. Barry (eds)., Academic Press, New York, 1097-1101 (1971).

The study is primarily concerned with global pollutants - sulfur, nitrogen oxide, carbon monoxide, hydrocarbon. For each of these, there is data concerning quantities, emissions, and sources. Two types of scavenging processes are: 1) oxidation and then the formation of aerosol particles and 2) surface absorption by vegetation.
Source: 5

#1590
Robinson, E. and R. C. Robbins. "Gaseous atmospheric pollutants from urban and natural sources." Global Eff. Environ. Pollut., Symp., Dallas. 15 p. (1968).

Natural and man-made source magnitudes, residual atmospheric concentrations, and scavenging processes are estimated for the major sulfur and nitrogen pollutants and carbon monoxide. One-third of the sulfur reaching the atmosphere comes from pollutant sources, mainly as sulfur dioxide. Within the atmosphere there is a net transfer of sulfur from land to ocean

areas. In the global atmospheric nitrogen cycle, pollutant emissions of nitrogen dioxide play only a minor role, and the cycle is apparently dominated by natural emissions of ammonia. Scavenging mechanisms for removing CO from the atmosphere are very speculative, but there is evidence of an oceanic source of natural CO to add to the principal global source, combustion processes (particularly the gasoline engine). The fact that trace amounts of a wide variety of compounds emanate from the natural environment emphasizes that there are processes present in the atmosphere which can scavenge the common pollutants emitted from urban sources. In the case of the more reactive gases, such as SO2 and NO2, these scavenging processes act relatively rapidly. The scavenging cycle is apparently as short as a day or so for SO2 and as long as a few years for CO. However, the fact that these cycles exist cannot be used as an excuse for permitting any urban area to reach detrimental levels of pollution, since none of the scavenging cycles described are effective enough within the time-frame of a few hours for them to have any significant effect within a given source area.
Source: 1

#293
Robinson, E., and R. C. Robbins. "Sources, abundance, and fate of gaseous atmospheric pollutants (final report)." Stanford Research Inst., Menlo Park, Calif., SRI-P 6755, 123 p. (February 1968).

An analysis of the sources, abundance, and fate of gaseous atmospheric pollutants is presented, considering three families of compounds; sulfurous, nitrogenous, and organic; and two inorganic carbon compounds; carbon monoxide and carbon dioxide. With the exception of CO_2, similar patterns of analyses of these materials followed and rather detailed analyses are produced. The presentation of CO_2 is only a brief review of the current state of thinking. Included are estimates of annual world-wide emissions of pollutants SO_2, H_2S, CO, NO_2, NH_3, and organics. The magnitudes of the natural emanations of a variety of materials have also been considered, although the means of estimating these emissions are very crude because so little study has been made of emissions from other than urban air pollution sources. Sulfur compounds, in the form of SO_2, are currently the most topical of the numerous air pollutants. Sulfur enters the atmosphere as air pollutants in the form of SO_2, H_2S, H_2SO_4, and particulate sulfates; and as natural emanations in the form of H_2S and sulfates. Among the various sources of CO, automobile exhaust accounts for more than 80% of the estimated world-wide CO emission. The major sources for the gaseous nitrogen compounds are biological action and organic decomposition in the soil and perhaps in the ocean. Aerosols containing NH_4 ions and NO_3 ion are formed by atmospheric reactions involving the various gases. Major contributions of hydrocarbons include natural CH_4 emissions from flooded paddy areas, terpene-class organics evolved by vegetation, and pollutant emissions. A brief review of present understanding of CO_2 in the atmosphere indicates a clear example of situation where pollutant emissions are significant enough to cause measurable changes in the ambient concentrations.
Source: 1

#961
Robinson, E., and R. C. Robbins. "Gaseous nitrogen compound pollutants from urban and natural sources." J. Air Poll. Control Assoc., 20:303-306 (1970).

Major aspects of the circulation through the atmospheric environment of a number of gaseous nitrogen pollutants have been estimated, including source magnitudes, residual atmospheric concentrations, and scavenging processes. The compounds considered include the major nitrogen oxide pollutants, as well as ammonia and nitrous oxide. Background concentrations of the various nitrogen compounds have been estimated. In the global atmospheric nitrogen cycle, pollutant emissions of NO_2 play only a minor role relative to the natural sources. The atmospheric nitrogen cycle is apparently dominated by natural emissions of ammonia, nitric oxide, and nitrous oxide. Scavenging mechanisms for removing nitrogen compounds from the atmosphere include surface reactions, the formation of nitrate and ammonium aerosols, and the biological reduction of nitrous oxide. Photochemical processes in the stratosphere are well known in the nitrous oxide cycle, but they appear to be less important than biological processes.
Source: 5

#1594
Robinson, E., and Robert C. Robbins. "Atmospheric carbon monoxide in the north and south Pacific Ocean areas." Preprint. Stanford Research Inst. Menlo Park, California, 25 p. (1971).

Atmospheric carbon monoxide measurements were conducted on shipboard in 1967 and 1968 during five cruises in the north and south Pacific Ocean. Air samples were collected in glass flasks and CO photometrically determined as mercury vapor by an instrument utilizing the reaction of CO with hot mercuric oxide. The CO concentration was highest (about 0.2 ppm) at about 40 degrees north latitude and lowest (0.04 ppm) at about 30 degrees south latitude in the Pacific area. Features of concentration profiles indicated the presence of a significant natural source of CO, probably the ocean; at the same time, the most likely explanation for the maximum zone at 40-50 deg N is considered to be the effect of northern hemisphere pollution sources in this latitude zone.
Source: 1

#664
Robinson, J. W., C. M. Christian, J. D. Martinez, and M. Nathany. "Spanish moss as an indicator of lead in the atmorphere before the use of leaded gasoline." Environ. Letters, 4(2):87-93 (1973).

Lead levels were determined in old and new samples of Spanish moss, an epiphyte which derives all of its sustinence from the air, in order to examine the extent of environmental Pb contamination resulting from the use of leaded gasoline. Similar levels of lead in both old and new moss indicated that Pb levels today in air remote from highways are similar to the Pb levels in the air before leaded gasoline was used.
Source: 1

#1595

Roenicke, G. and R. Graul. "Die ablagerungen von luftverunreinigungen an wasseroberflaechen." [Deposition of air pollutants on surface water]. Staub, Reinhaltung Luft, 30(9):378-379 (Sept. 1970).

Precipitations from the air are responsible, among other factors, for the pollution of surface water. The extent of pollution caused by these precipitations is investigated, with the conditions prevailing in the lake, Bodensee taken as an example. The concentrations of trace substances present in the air are measured simultaneously. An empirical formula is derived from the data obtained which gives, for known concentrations of air pollutants, the amount of precipitation on the water surface. The influence of land-water air currents in the case of large lakes on the increase in air pollutants is discussed.
Source: 1

#1688

Rogalinski, K. and Z. Muszynski. "Lasy znajdujase sie w strefie szkodliwego oddzialywania gazow i pylow przemyslowych okolic brynicy i zyglinek." (Forests situated in the zone of the noxious action of industrial gases and dusts in the area of Brynica and Zyglinek). Ministry of Forestry and Timber Industry, Cracow, Poland, Commission for Forest Administration and Replanting in Industrial Districts, 4(23) ,36 pp. (1971).

A detailed inventory has been made of forests situated in Brynica and Zyglinek which are within reach of indistrial emissions of dusts and gaseous pollutants. Data were collected on forest abode types, climate, geology, soil type, and health condition of the trees. Installation of a zinc works and a sulfuric acid factory in the area investigated appears to have resulted in a marked increase in the amount of deadwood found, especially in the northern part of the forest complex. Mineral dusts of silica, magnesium oxide, and calcium oxide have covered large sections of the edge of tree stands, and sulfur dioxide emissions from the sulfuric acid factory have resulted in considerable destruction of nearby orchards as well as complete browning of pine needles in sections of the stands. The assimilation apparatus of leafy trees encircling the factory has also been subjected to destruction. The presence of harassing pests is also indicative of the weakened condition of the forests within range of the noxious industrial emissions. The average timber reserve in cu m/ha has dropped considerably and was found to range from 150-68 cu m/ha.
Source: 1

#1214

Rohmeder, E. "Die Wirkung von Staub und RuB auf den Zuwachs der Fichte." (Effects of dust and soot on pine tree growth). University of Munich, 4 pp., (1959).

The experiment was performed over a period of two years on 40 three year old pines having identical genetic stock. The effects of thorough and consistent dusting with street dust, carbonic lime, and soot on their growth was tested. The trees were heavily dusted during the whole growth period of 1956. The following year the treated trees showed a considerable reduction in height growth and in production of shoots and needles compared to those trees not treated. The production of roots was also reduced. This growth reduction is mainly considered to be due to reduced light which would reduce the rate of photosynthesis. When soot was dusted, the damage was increased by the caustic effects of the chemicals contained in the soot.
Source: 6

#1846

Rohmeder, E., W. Merz, and A.V. Schoenborn. "Zuchtung von gegen Industrieabgase relativ resistenten Fichten- und Kiefernsorten." (The breeding of spruce and pine species which are relatively resistant against industrial waste gases). Forstwiss. Zentr., 81 (1962).

Methods for determining the relative sensitivity of various types of coniferous trees to industrial waste gases are discussed, and attempts to breed more resistant strains of trees are described. Phenotypically resistant spruce trees are selected from damaged areas and used to supply grafts for testing purposes. The fact that the resistance is based on heredity is determined by exposing the grafts, along with pure sensitive samples, to varying concentrations of sulfur dioxide gas and hydrogen fluorine gas. No visible damage occurred on the grafts, while the others indicated symptoms. The chemical analysis of needles from resistant trees shows that they have lower sulfur values than more sensitive trees do. The resistant cuttings can be propagated and distributed in areas where more sensitive trees cannot survive.
Source: 1

#861

Rohmeder,Ernest and Alexander von Schonborn. "The breeding of spruce with increased resistance to exhaust gas." Proc. Congr. Intern. Union Forest Research Organizations, 14th, Munich, West Germany, 5(Sect. 24):556-566 (1967).

Thirty-six spruce of average age were selected from stands severely damaged by smoke in West Germany; the chosen trees remained somewhat healthy and productive in spite of severe exposure to smoke. About 7000 shoots were obtained by means of grafts from the selected trees. In greenhouse fumigation experiments with exactly measured concentrations of sulfur dioxide and hydrogen fluoride, the grafts

displayed considerably more resistance than grafts whose shoots stemmed from spruce living more than 100 years in the high mountains. It was demonstrated that the characteristic of heightened resistance to exhaust gas is based in the genetic spectrum. The resistant grafts were even less damaged by SO2 and HF, and by fumigation mixtures, than were other kinds of conifers and decidious trees. Only the oak tolerated even higher SO2 and HF concentrations than did the resistant grafts. The greenhouse fumigation experiments clarified which environmental factors influence the smoke resistance of forest trees. It was found that the higher the relative humidity, the higher the light intensity, or the higher the assimilation intensity, the greater the damage to forest trees. During the winter, forest trees contain higher concentrations of components such as SO2 than in the summer. Optimally nourished plants endure higher concentrations than do plants cared for with insufficient nutrients.
Source: 1

#1689
Rohmeder, Von E. and E. Weber. "Vergiftung von Fichten durch Flugzeugabgase." (Poisoning of spruce by aircraft exhaust gases). Forstwiss. Zentralbl., 89:335-339 (1970).

Injuries to spruce trees of varying age located in a forest area 8 km east-northeast of Munich airport have been observed for several years and are attributed to the smoke emissions from overhead aircraft. The extent of the damage has ranged from red discoloration of needles to complete death of the trees, and chemical analysis of one and two year old needles has revealed a higher than normal lead content. Influences by insects and fungi have not been traced. The forest is situated underneath the flight path of arriving and departing airplanes, and on calm days a trail of black smoke is deposited onto the forest. It is probable that other substances such as unsaturated hydrocarbons in the aircraft emissions have also contributed to the damage of the spruce stands.
Source: 1

#140
Romney, E. M., R. G. Lindberg, H. A. Hawthorne, B. G. Bystrom and K. H. Larson. "Contamination of plant foliage with radioactive fallout." Ecology, 44:343-349 (1963).

Studies on the contamination of plant foliage by radioactive fallout originating from nuclear detonations at the Nevada Test Site were conducted during the 1955 and 1957 weapons-testing series.

Fallout particles intercepted by plant foliage were principally of sizes smaller than 44 μ diameter. The foliage of most forage plants selectively trapped these small-sized particles in the matted hairs and crevices and on resinous glands of the leaf surface. The varying capacities for retaining fallout particles largely depended upon the mechanical-trapping characteristics of leaf surface.

Within distances downwind from detonation corresponding to 12 hours fallout time-of-arrival (less than 250 miles), there was good correlation between the beta activity of fallout lodged on plant foliage and the beta activity of smaller than 44 μ diameter fallout particles deposited at the sampling site. The size of fallout particles generally decreased at greater distance downwind from detonation causing an increase in the percentage of fallout lodged on plant foliage.

Fallout particles lodged on plant foliage could not be completely removed; however, the radioactive contamination could be reduced to less than one-half by washing in mild detergents and chelating agents. Wind action effectively reduced the level of contamination initially deposited on plant foliage.

The solubility of fallout lodged on plant foliage from tower-supported detonations varied from 5 to 35% in 0.1 N HCl as compared to 60 to 90% for fallout from balloon-supported detonations.

The major contributors to the beta activity in the smaller than 44 u diameter fallout particles at 90 days after detonation were radioisotopes of cerium, yttrium, and zirconium which, together, contributed about 60%. Radiostrontium accounted for nearly 5% of the beta activity and radiocesium contributed less than 1%.
Source: 7

#1184
Ronicke, Dr. G., and R. Graul. "The deposition of air pollutants on water surfaces." Staub-Reinhalt Luft, 30(9):21-24 (1970).

Precipitations from the air are also responsible among other factors, for the pollution of surface water. The extent of pollution caused by these precipitations has been investigated, the conditions prevailing in the lake Bodensee being taken as an example. The concentrations of trace substances present in the air have been measured simultaneously. An empirical formula has been derived from the data obtained which gives, for known concentration of air pollutants, the amount of precipitation on water surface. The influence of land-water air currents in the case of large lakes on the increase in air pollutants is discussed.
Source: 6

#310
Roosen, R.G., R.J. Angione and C.H. Klemcke. "Worldwide variations in atmospheric transmission: 1. Baseline results from Smithsonian observations." Bull. Am. Meterol. Soc., 54(4):307-316 (April 1973).

Analysis is made of atmospheric transmission measurements taken during the first half of the twentieth century at 13 widely separated sites by the Astrophysical Observatory of Smithsonian Institution. Long and short period variations in atmospheric transmission are examined for the individual sites.

Significant variations from one day to the next are not unusual. Seasonal variations are found for all sites, with characteristic summer maxima. The variations appear to be due almost entirely to variations in the aerosol component above the observing sites. The observed phases of these variations, the derived characteristic size distributions of the particles which cause them, and the correlations between atmospheric moisture and transmission lead to the conclusion that differences in the nature and sources of aerosols above arid and vegetated regions are detectable. More recent studies indicate that except for sporadic perturbations due to volcanic activity, there has been no detectable change in the global atmospheric transmission measured from remote, high altitude sites in the last half century.
Source: 1

#663
Rose, Francis. "Lichens as pollution indicators." Your Environ., 1(5):185-189 (1970).

Because of their sensitivity to toxic gases, lichens, especially epiphytic varieties offer a means of biological assay of air pollution effects. In general, damage to lichens or the disappearance of sensitive species correlates best with mean winter levels of sulfur dioxide, measured in microgram/cu m. The effect of peak levels is less well known and less easy to correlate because of the lack of data. Since adequate measurements of SO2 are usually available in highly polluted areas, it is in rural areas that lichens are most valuable as pollution indicators. Detailed maps have been prepared for southeast England of the occurrence of lichen species with different specific tolerances to SO2. These maps show clear patterns of occurrence in successive zones south from London, the zone corresponding well with measured mean winter SO2 values.
Source: 1

#1128
Rosinski, J., and C. T. Nagamoto. "Particle deposition on and reentrainment from coniferous trees. Part I: Experiments with trees." Kolloid Z. Z. Polym. 204(1/2):111-119 (July/August 1965)

In wind tunnel experiments using a fluorescent zinc sulfide tracer, deposition of dry solid particles of two-micron diameter on the leaves of Juniperus scopulorum sarg. (red cedar) and Pseu dostsuga taxifolia (poir.) Britt. (Douglas fir) was found to follow two different modes, which are dependent on dose. Deposition can be expressed by ln C + k1 equals k2 in D where C is area coverage, D is dose, and k1 and k2 change values at a dose equal to three to seven times ten to the ninth particles per cross section of a tree. Reentrainment of particles from leaves located in the upwind section of a tree differed appreciably from reentrainment of particles from leaves located in the downwind section. Particles blown off from the upwind part of the tree were deposited on leaves located in the downwind section during the first half hour. The experiments were conducted at four wind speeds: 195, 280, 410, and 710 cm/sec. At 280 cm/sec deposition was maximal and rate of reentrainment was minimal.
Source: 1

#1191

Ross, J.M., R.H. Wade and H.M. Benedict. "Rapid field method for determination of fluoride in plants." Journal of the A.O.A.C., 46(5):907-908 (1963).

This paper describes a simple field method for the semi-quantitative detection of microgram quantitites of fluorides in plant tissues without the need for preliminary drying, fusion and/or combustion or distillation.
Source: 6

#1089

Rowland, et al. "Natural halocarbons in air and sea." Nature, 258(5537):775 (1975).

The amount of stratospheric chlorine released from natural CH_3Cl probably cannot be considered as great a hazard to the ozone as CCl_2F and CCl_3F, anthropogenic molecular, which release chlorine atoms. One reason for the potential danger of a molecule as CCl_3F is it's long atmospheric lifetime and the rapid increases of these molecules in recent years. On the other hand, natural CH_3Cl has a short lifetime and man annual average basis, is present at steady levels. Ozone removal by stratospheric chemical processes involves NO_x catalysis, H_xO catalysis, and direct reaction.
Source: 1

#862

Ruhling, A. "Tungmetallfororeningar inom Vargon-Trollhattanomradet." [Heavy metals within the region of Vargo-Trollhattan]. Lund Univ., Inst. of Ecological Botany, Sweden. Rept. 14. 22 p. (April 1970).

Measurements of heavy metals were made within a region where heavy industry is situated. A common sort of moss, Hypnum cupressiforme, was analyzed at 127 sites for lead, iron, cadmium, cobalt, copper, chromium, manganese, molybedenum, nickel, vanadium, and zinc. The mosses were at least 100 m from any road to prevent the possibility of automotive contamination. In general, very high values of metals were observed in the mosses. For example, in the region of a ferro-alloy plant, concentrations as high as 12,000 ppm of chromium and 30,000 ppm of manganese were found. The normal values for Sweden are 10 and 200 ppm respectively.
Source: 1

#784

Ruhling, A. "Tungematallfororeningar inom Vargon-Trollhattanomradet. II. Arsenik, Kvicksilver." [Heavy metals in the region of Vargon-Trollhattan. II. Arsenic and mercury]. Lund Univ., Inst. of Ecological Botany, Sweden. Rept. 15, 8 p. (May 1970).

Arsenic and mercury were measured in a common moss, Hypnum cupressiforme, in the region of Vargon-Trollhattan, Sweden. Three samples were taken from each of 127 sites, all more than 100 m from any road. The region studied is highly industrialized with iron, steel, and ferro-alloy industries. No exceptionally high values were observed.
Source: 1

#357
Ruhling, A., and G. Tyler. "An ecological approach to the lead problem." Botan. Notiser, 121:321-342 (1968).

In order to measure lead accumulation levels in Sweden, the concentration of lead in plants and soil was determined in transects across three large roads as well as at sites far from roads; uptake of lead by plant roots was also investigated in greenhouse experiments. Considerable accumulations were measured in plants and soil within a 50-100 m distance from the roads, although only a minor part of the lead emitted from cars settles and accumulates in the vicinity of the roads. To determine regional lead pollution, moss samples from distant roads in southern and central Scandinavia showed a distinct NE-SW gradient which decreased towards the NE. The lead concentration increased with precipitation and with decreasing distance from large population centers; in one area, much of the rain precipitated lead originated outside of Sweden. Mosses appear to be useful indicator plants, since they naturally contain very little lead but accumulate it from the air to an unusual extent. A historical analysis of mosses collected in Skane from 1860 to 1968 showed marked increases in lead concentration in these samples, restricted to two distinct periods; the first occurred toward the end of the nineteenth century; and the second, during the last two decades. The first may be explained by the increased use of coal while the second coincides with the rapid increase in the combustion of leaded automotive fuels. Very low lead concentrations were measured in samples from northern Scandinavia.
Source: 1

#356
Ruhling, A., and G. Tyler. "Sorption and retention of heavy metals in the woodland moss Hylocomium splendens (hedw.) br. et sch." Oikos, 21(1); 92-97 (1970).

The capacity of Hylocomium splendens to absorb heavy metal ions from dilute solutions was investigated. The sorption and retention generally followed the order: copper or lead greater than nickel greater than cobalt greater than zinc or manganese. This order proved valid within a wide range of concentrations and independently whether the ions were supplied in pure or mixed solutions. The capacity of the moss tissues to sorb traces of Cu and Pb in the presence of comparatively large amounts of calcium, potassium, magnesium, and sodium was very great. This makes it probable that these ions, supplied with the precipitation, are almost quantitatively sorbed by the moss carpets. A large share of Ni when present in precipitation, will also possibly be sorbed. A natural carpet of Hylocomium splendens showed a continuous uptake of manganese, iron, and Ca from young to old tissues, whereas the increase in the concentrations of minor heavy metals was balanced by the dry matter decrease through decomposition. The developing and mature layer below the moss carpet had no enriched heavy metals above the concentrations of the old moss tissues.
Source: 1

#665
Ruhling, A. and G. Tyler. "Heavy metal deposition in Scandinavia." Water, Air, Soil Pollut., 2(4):445-455 (Dec. 1973).

Maps showing the regional differences in the atmospheric deposition of lead, cadmium, mercury, chromium, nickel, copper, zinc, and iron were prepared for Finland, Norway, and Sweden from data obtained by means of moss analysis, a method previously known to be a sensitive and reliable tool in measuring heavy metal deposition. All the elements in the minima were recorded in northern Norway, the maxima were in southcentral or southwestern Sweden and southernmost Norway. The greatest regional differences were measured in Pb and Cd. Possible sources of error are mentioned.
Source: 1

#736
Runeckles, V.C. "Dosage of air pollutants and damage to vegetation." Environ. Conserv., 1(4):305-308 (Winter 1974).

Much of the published research on the effects of air pollutants on plants suffers from a lack of understanding of the relationship between the conditions employed and naturally occurring concentrations of pollutant. Frequently lacking is information as to the effective dosages of pollutants used in laboratory studies. The importance of dosage is discussed, as is its relation to concentration and flux. It is suggested that a greater interrelationship between observations from different research workers would be achieved by the simple expedient of measuring pollutant uptake by the plants under study, rather than merely describing concentrations in the surrounding air.
Source: 2

#133
Russell, R.S. "An introductory review - Interception and retention of airborne materials on plants." Health Physics, 11:1305-1315 (1965).

In a Symposium on Radiation and Terrestrial Ecosystems, it is appropriate to discuss the interception and retention of airborne materials in plants only insofar as these processes influence the total radiation dose to which members of ecosystems may be subject. Consideration is given to the circumstances when this occurs and reasons are advanced why it is particularly relevant to consider those ecosystems which Man has created or modified. Quantitative information on the extent to which particulate deposits are retained on different types of plant surface is at present meagre. The further study on this subject deserves encouragement since the external radiation dose, especially from beta radiation, which is received by tissues which are particularly sensitive to the effects of radiation could be greatly modified. The retention of finely divided deposits on crop plants and its subsequent loss of radioactivity due to mechanical and other processes have been studied in greater detail. Quantitative relationships are discussed with respect to those nuclides which are the major sources of internal radiation. Recent evidence suggests that the direct contamination of vegetation can be responsible for a still larger fraction of the ^{90}Sr which enters food chains than was formerly supposed.
Source: 7

#309
Russell, V.S. "Pollution: Concept and definition." Biol. Conserv., 6(3):157-161 (July 1974).

Air pollution is defined by the Senate Select Committee Report on Air Pollution, Australia Parliament, 1969. It is the act of causing air to contain concentrations of foreign matter in excess or normal values and which adversely affect the health of human beings, their property and comfort, the comfort or health or animals, or the health of plants. This definition fails to differentiate between air pollution resulting from the controllable activities of man and the natural emissions of particulates and gases over which there is no control. More particulate matter and more combined gases were forced into the atmosphere by the volcanic eruptions of Krakutau in Java in 1883, by Mt. Katmal in Alaska in 1912, and by Mt. Hekla in Iceland in 1947 than by all the activities of a man in recorded history. Greenbelts aid in the dilution and removal of pollutants,but air pollution control should be regarded as an integral part of the industrial process, and responsibility for it should lie with the industry,not with the municipal authorities responsible for parklands.
Source: 1

#1941
Rutsch, H. C. "Heavy metal accumulation in soil and vegetation from smelter emission." Environmental Protection Agency. National Environ. Research Center. EPA-660/3-74-012. Office of Research and Development, U.S.EPA Corvallis, Oregon (August 1974).

Soil and plant samples were collected along north-south and northeast-southwest transects radiating out from the Tacoma Smelter. The concentrations of lead, arsenic, cadmium and mercury in garden soil decline with increasing distance from the smelter. The concentrations of arsenic and cadmium in vegetation also decrease at increasing distance from the smelter, but lead and mercury concentrations did not appear to be related to distance from the smelter.

The heavy-metal levels in the samples demonstrate the accumulation of large amounts of metals in surface soils and the availability of metals to plants. When these values are compared to "average" heavy-metal contents a deterioration of the quality of the soil and the presence of heavy-metals at levels toxic to some plants is shown.
Source: 5

#786
Ryabinin, V. M. "The Effect of Industrial Gas on the Growth of Trees and Shrubs." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects and Symptoms of Air Pollutes on Vegetation. Resistance and Susceptibility of Different Plant Species in Various Habitats. In Relation to Plant Utilization for Shelter Belts and as Biological Indicators. M. Y. Nuttonson (ed.), Vo. 2, Silver Spring, Md., American Institute of Crop Ecology (1969) p. 13-18. (Also: Nauk USSR Vsesoyuznoe botan. obschestuo. Zh. Botan., 47(3):412-416 (1962).

Industrial gases disturb the physiological and biological processes of plants. To study the growth and viability of certain trees under smoke pollution conditions, three experimental plots were laid out in the Shchelkovo Forest of the Moscow district. The effects of sulfur dioxide, nitrogen oxides, hydrogen sulfide, and hydrogen chloride were observed. Three control plots were established in the Malakhov Forest. The results showed that under the influence of industrial gases there is a decrease in the size of needles and leaves, and the life span of needles is half what it would normally be. The assimilating surface of the trees and shrubs is thus sharply decreased. A weakening of growth was observed in coniferous and deciduous species; the cause is the repression of photosynthesis due to the reduction of assimilating surface. With an increase in distance from the pollution source, the difference in growth between exposed and control trees gradually disappears.
Source: 1

#1849

Ryder, E.J. "Selection and breeding of plants for increased resistance to air pollutants." Presented at the American Chemical Society, National Meeting. 161st, Los Angeles, Cal. (March 28, - April 2, 1971).

A few crops, ornamental plants, and forest plants were investigated for variations in reaction to air pollution. Evidence for a genetic basis for resistance to pollutants was found in several species. Plant breeding techniques and current breeding programs are listed. The effects of the following toxicants are reviewed: ozone, fluoride, oxidants, sulfur dioxide, nitrogen dioxide, and peroxyacetyl nitrate. Future needs and prospects are discussed. Breeding new varieties of plants, resistant to the toxicants, which can be successfully grown in a polluted atmosphere is considered.
Source: 1

#1005

Ryder, E.J. "Selecting and breeding plants for increased resistance to air pollutants." Adv. Chem. Ser., 122:75-84 (1973).

Few plant species have been investigated for variation in reaction to air pollution. Evidence for a genetic basis for resistance has been found in several species. Little is known of plant response to two or more pollutants and of the physical basis for resistance. Breeding new varieties resistant to air pollutants may be carried on despite the absence of some fundamental knowledge. Breeding procedures include selection of resistant plants out of an existing population and crossing of sensitive with resistant plants followed by selection of new types combining favorable characteristics of both parents. Present breeding programs are listed. Future needs and prospects are discussed.
Source: 5

#1740

Saeki, M. K. Kunii, S. Izumida, and T. Kumagaya. "Chii-rui o shihyo to suru taiki osen no sokutei ni kansuru kenkyu- Sendashi oyobi shuhen no hakaishi ni chaku-sei suru chiirui ni tsuite (dai 1 ppo)." (Studies on the determination of air pollution utilizing lichens as index. Part I: on the lichens growing on tombstones in Sendai City and its surroundings). Sendaishi Koshu Eisei Kenkyu Gyosekishu, pp. 139-141. (March, 1974).

To determine air quality in Sendai City, lichens on tombstones in six cities were examined. Eighteen species of leafy lichens were used as plant indicators because of ease of identification and differing toxic tolerances of some species within a genus to air pollution.
Source: 1

#1736

Saitama Prefectural Government (Japan), Bureau of Education, Horticultural Experiment Station, and Pollution Control Center. "Shokubutsu ni yoru taiki osen chosa hokokusho." (An investigation of air pollution by a plant survey). 16 p. (1974).

Morning glories, coxcombs, and scallions were used as indicators to see the relationship between oxidant level and plant damages in Saitama prefecture. Thirty-two elementary and junior high schools were selected, one per 25 sq km, as locations of testing, and eight locations with oxidant monitoring stations were selected as control areas. Morning glory species were heavenly blue (HB) and purple lions, coxcombs were scarlet giant (SG) and kincho (K). On May 13 when oxidant level was high (cumulative level 90 pphm), HB were seriously damaged in three locations, lightly damaged in three other locations, and SG were lightly damaged at 10 locations. The K was damaged heavily at three locations. The minimum level for clear visually damages was 90 pphm (hourly average 10 pphm). The damages on HB leaves were white mottles between veins. On SG, shapeless yellow-white spots appeared between veins. On the day of high oxidant in August (250 pphm cumulative; 6.9 pphm hourly), damages were much more serious, and chlorosis and necrosis appeared. Morning glories were the most appropriate and sensitive indicator, and coxcombs and scallions were less sensitive. The last two were not suitable also because the leaf regeneration was slow and it was difficult to judge the oxidant damages when the concentration was high over a period of time. The HB was a good indicator , but rather quickly deteriorated and it was difficult to care for. There was a correlation between oxidant concentration and plant damages, but areas with high oxidant concentrations were not necessarily damaged. Micrometerology and the growth condition of indicators also seemed to affect damages. In early August, damages occured not only in polluted areas but in control areas also, and further investigation is required.
Source: 1

#1744

Sakamoto, Clarence M. and Ray E. Jensen. "Quarterly report on effect of climatic change on non-domestic wheat production." National Oceanic and Atmospheric Administration, Auburn, Ala., Environmental Study Service Center, Department of Transportation Climatic Impact Assessment Program Proj. DOT-AS-400006, 89 p. (1974).

Engine effluents from aircraft in the stratosphere and other pollutants could alter the global energy balance. This could cause changes in mean temperature, wind precipitation, and solar radiation at four divisions of latitude (0-20 deg, 20-40 deg, 40-60 deg, and 60-90 deg) for four cases of change in solar radiation. The possible effects of these four cases at these four latitudes on nondomestic wheat production are reviewed. Argentina, Australia, Canada,China, India, and the USSR are considered. The requirements of wheat involving weather and soil are discussed. The historical effects of weather changes on production are described. General characteristics of wheat and characteristics of the wheat producing areas are also discussed.
Source: 1

#1612

Sandberg, D.V., and R.E. Martin, "Measurement of particulate emissions from forest residues in open burning experiments." University of Washington(1974).

A program of burning experiments was carried out to assess the air pollutant emissions potential of forest residues in the Pacific Northwest. Only the fine fuel componentof slash fuelbeds was considered. Ponderosa pine slash, Douglas-fir slash with needles, and Douglas-fir slash without needles was burned in special laboratories at the University of Washington, Seattle, and the University of California, Riverside. In two field experiments at slash burning operations in Washington, particulate emission factors were calculated for comparison with laboratory results.

Particulate emission from thirteen Ponderosa pine fuelbeds averaged 12.5 lb/ton of fuel burned. Hydrocarbon emissions averaged 12 lb/ton of fuel burned and carbon monoxide emissions averaged 195 lb/ton for ten Ponderosa fuelbeds. Nine fuelbeds treated with a flame retardant released 30 pounds of particulates, 18 pounds of hydrocarbons, and 257 pounds of carbon monoxide per ton of fuel burned.

Particulate emissions from twenty-three fuelbeds of Douglas-fir slash without needles averaged 6 lb/ton of fuel burned. Fuelbeds with needles released 24 lb/ton in six experiments.

Particulate emissions from a field experiment in fuelbed having large and rotten material, but no needles or associated vegetation was 28 lb/ton. The emission factor for a complex fuelbed with all of the above components was estimated at 107 lb/ton of fuel burned.

A sampling period emission factor for particulates was calculated by dividing the weight of pollutant released by the weight of fuel burned in each filter period at the University of Washington Laboratory. A twenty-second period emission factor for hydrocarbons and carbon monoxide was calculated for the Riverside fuelbeds. In all cases, the period emission factors were nearly inversely proportional to the rate of fuel consumption. However, fuelbeds with burning needles released approximately seven times the particulates as released by twigs and branches alone burning at the same rate. Smouldering fuelbeds released one-quarter the particulates relative to fuel burned, as a flaming fuelbed at the same intensity.
Source: 3

#1737
Sarosiek, J.B., Twarda, B. Bury-Burzymska, and D. Kowaliszyn. "Uszkodzenie roslin wywolane dymami poflotacyjnymi Kombinatu Miedziowego w Lubininie." (Damage to plants caused by post floatation smokes from the copper combine of Lubin). Ochrona Powietrza, 6(3):17-23 (1972).

Because of the planned further development of the Copper Combine of the Lubin District Mining Company and of the appraisal of previous damages to pine forest by post floatation smoke, it was necessary to study the susceptibility of various wild plant species to the toxic properties of the smoke. Tentative investigations conducted during the growing season of 1970 made it clear that out of 136 species of examined green plants, trees, and shrubs, 35 displayed symptoms of disease, and in 26 of them the post floatation smoke was the pathogenic agent. These finding and an assessment of ecological conditions in the area provide the means for determining the danger of the post floatation smoke and for amending the borders of the danger zone for pine forests in Lublin and at Polkowice.
Source: 1

#1738
Sato, A., and H. Yamamoto. "Iwateken no kogai ni kansuru kenkyu dai-15-ho: Miyako-shi no genmai, yasai, oyobi, dojo nado no jukinzoku chosa ni tsuite." (Study on environmental pollution in Iwate Prefecture -- 15th report: Survey of heavy metals contained in unhulled rice, vegetables, and soil in Miyako City). Iwate-ken Eisei Kenkyusho Nenpo (Ann. Rept. Iwate Inst. Public Health), 14(1970):57-77 (December 1971).

In June 1969, the measurement of suspended particulates and metal analysis accidentally uncovered more than 0.1 micrograms/cu m of cadmium in the air. Subsequently, a number of investigations were conducted to see the extent of water and air pollution caused by the stack gas from a factory. The contents of cd, lead, manganese, copper, and zinc were analyzed in unhulled rice and the soil of the rice paddies, vegetables and the soil, and the soil in the vicinity of the factory. A maximum of 3.2 ppm of Cd was found in unhulled

rice, and 0.25 to 4.55 ppm (1.22 average) in the rice paddies, but there was no correlation between the contents in the rice and in the paddies. Other Cd contents were 0.13 ppm in scallions, 0.08 ppm in potatoes, 0.05 ppm in cabbage, and 0.8 ppm in the soil. In rice, Pb was found in a relatively high concentration compared with other areas. In newly harvested rice, both Cd and Pb contents were high but Mn, Cu, and Zn were low. The maximum allowable standard of Cd in rice in specially monitored areas is 0.4 ppm, but the total average of Cd in old rice of this area was 0.86 ppm, more than 10 times the average of Cd content of polished rice in the entire country.
Source: 1

#1739
Sato, Haruo. "Cultivation of Lemna paucicostata Hegelm with polluted rainwater in Osaka." Japan Society of Air Pollution, Proc. Symp. Japan Soc. Air Pollut., 13th, p. 223, Paper 177 (Nov 9, 1972).

Air pollution precipitates in the rain which cleans the air. Using rainwater sampled at 16 locations in Osaka city, Lemina paucicostata Hegelm (a drifting aquatic plant) was cultivated. Water was collected every 4 months, and an equal amount of plant food was added to the water. The results of growth varied from 2.3 to 4.5. In general, the growth rate was better toward the inland area, the eastern suburbs of Osaka, and growth rates were 2.3 or 2.5 closer to the shore industrial areas and central Osaka. The effects of copper, zinc, and other metal pollutants, and low pH are suspected; but the nature of the damages is probably extremely complex and multiplied by mutual reactions among the pollutants.
Source: 1

#1741
Sato, T. "Taiki osendo to jumoku no yochu ioganyruyo no kankei." (Relation between air pollution and sulfur content in tree leaves). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):153 (1970).

Leaves of zelkova trees were examined for their sulfur content and its variation over time. Samples were taken from the western suburbs and from the old city of Tokyo. Total sulfur content was much higher in the old city. It increased rapidly from May to June (0.6 ppm and over) and then leveled off. In the suburbs, total sulfur content was more or less constant from spring to summer at about 0.2 ppm. The content of water-soluble inorganic sulfur was always higher in the polluted old city than in the suburbs; it increased rapidly from the end of May to the end of June, then tapered off in August. The content of water-soluble organic sulfur decreased from spring to summer, but no close connection with pollution was observed. The unusually high leaf face exhibited by zelkova trees from the end of June to the end of July in recent years corresponds quite closely to air pollution observations obtained by the lead peroxide candle method.
Source: 1

#380
Saunders, P. J.W. "Effects of atmospheric pollution on leaf surface microflora." Pestic. Sci., 4(4):589-595 (1973).

The nature and dynamics of atmospheric pollution are discussed, along with their effects on the leaf surface microflora of the higher plants. Upon deposition, gaseous pollutants enter the leaf with an unknown proportion being retained with particulates on the leaf surface where absorption into the surface moisture occurs. The leaf surface microflora must cope with changes in their substrates caused by the pollution as well as the direct effects of the pollution. Information on the effects of pollutants on the microflora is limited and relates mostly to sulfur dioxide. Observations in vivo and tests in vitro suggest that different species differ sufficiently in their responses to this pollutant, especially during germination, so that selective sterilization of the leaf surface can be used to change the composition of its microflora and provide additional living space for less sensitive inhabitants. The effects of other pollutants are uncertain, but alkaline dusts and ozone can stimulate or inhibit the development of some fungi found on the leaf surface.
Source: 1

#1742
Sawada, M. and H. Akiyama. "Asagao de kokagaku sumoggu o chosa - ha no henka de osen nodo o sokutei." (Investigation of photochemical smog by morning glory: Determination of pollutant concentration by observing the change of leaves). PPM (Japan), 5(7):74-81 (July 1974).

In Japan leaf changes in morning glory has been used to determine quantitatively oxidant concentrations. White spots on the upper side of the leaf indicate slight damage, and spot-like perforations of the leaf shows a severe case. Annual plants and deciduous trees are most susceptible to oxidants. Appropriate plant indicators must be susceptible to oxidants broadly cultivated, show most conspicuous damage to the naked eye, and be resistant to disease and harmful insects. The degree of damage to Morning glories, was classified into three levels indicated by a water soaked-like state, peripheral white spots and greyish-whitening of leaf blade slowly turning to black specks, and finally brownish blackening and curling of the leaf-blade. These phenomena correspond respectively, to 0.15 ppm (1-2 hr) 0.15-0.2 ppm, and more than 0.2 ppm (daily oxidant dose) (9 am to 4 pm) of 100 ppm (cummulative of hourly average value).
Source: 1

#1747
Sawada, Tadashi, Tetsuto Komeiji, Isamu Nouchi, Kuniko Oguchi, and Toshio Odaira. "Kokagaku sumoggu no eikyo to omowareru shokubutsu no higai jokyo ni tsuite (dainiho)." (Injury by photochemical smog as observed and reflected on plants in Tokyo (2)). Proc. Symp. Japan Soc. Air Pollut., 13th, Paper 186, p. 232 (Nov 7-9, 1972).

Plant damage was investigated in 78 communities in suburban Tokyo between Aug. and Oct. 1971. Five hundred and twelve samplings of 19 species of vegetables and plants were gathered. A total of 54 samplings of green vegetables, spinach, turnips, scalions, radishes, corn, and morning glory showed some damage. Chlorosis and mottling were noted on many green vegetables. The damages on morning glory plants especially showed blackening of leaves on the morning after oxidant exposure, white spots appearing two days later, and the shapes of leaves changed into cups on upper stems. Necrosis symptoms appeared gradually, and in severe cases, the leaves fell off. The tree samples were mostly taken from parks. Zalcova trees and Carolina poplars were stripped from June to July in the total area, showing no geographical differences. However a high rate of necrosis of zalcova trees was noted in the area with a high sulfur dioxide concentration. An ozone exposure experiment was conducted on these plants and vegetables using an exposure chamber. Chlorosis and necrosis similar to the out-of-door symptoms appeared on all vegetables and trees.
Source: 1

#667
Sawada, Tadashi, Tetsuto Komeiji, Isamu Nouchi, Takeshi Ohashi, and Toshio Odaira. "Asagao no kishidanto (Ox) shikyosei ni tsuite." (Discussion of morning glory as oxidant index). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):541 (Oct. 1973).

As a study for examining morning glory a susceptibility as a plant indicator, the condition of damages on leaves were examined at various parts of Tokyo. The degrees of damages were classified into four categories: light damages which do not produce visible sign immediately, but chlorosis or discoloration appear after a period of time; medium damages in which the day after the exposure to oxidant produces an oily appearance and then white spots in one or two days; serious damages in which only oily spots appear between veins immediately after the exposure, and in one or two days, they turn yellow-white, and black mottling also occurs; and a different type of damage in which silvery, elongated spots appear on the back of relatively young leaves along the veins. This last type may be the result of peroxyactyl nitrate, but it has not been confirmed. The positions of leaves have no relative to susceptibility to ozone, and the limits of susceptibility is about 15 days. The first three types of damages appear between June and September, and the last appear between May and July in Tokyo. Damages occur when the oxidant level is more than 15 pphm, and the length of exposure more than 2 hr. The minimum damage-producing cumulative oxidants is 80 (based on the cumulative values of 9-16 hours).
Source: 1

#1746

Sawada, T., T. Komeiji, I. Nouchi, T. Ohashi, T. Odaira, N. Date, T. Iijima, K. Terakado, M. Iwanami, T. Yoneyama, and H. Fukuda. "Itto sanken shokubutsu higai koiki chosa kekka ni tsuite." (On the result of wide-area investigation of plant damage in Tokyo and the three neighboring prefectures). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 673-694 (March 1974).

The status of plant damage due to environmental pollution by oxidant was investigated. The plants utilized as pollution indicators were spinach (New-asia variety), radish, and two varieties of morning glory, Scarlet O'Hara and Violet, all potted and buried in the soil of monitoring points (17 points near air pollution monitoring stations) distributed in Tokyo. Maize, taro, and 5 other species were utilized as indicators. The days of damage-investigation were June 23 (2 days after a highly polluted day) and July 30 (4 days after a highly polluted day). After the high oxidant concentration of June 21, the damage to spinach was high in the center of the city and was lower in suburbs, and did not appear west of Tachikawa. The damage symptoms were intervenal spots of necrosis and chlorosis with irregular form with some silvering and oily immersion points severely damaged by oxidant. No damage was observed on morning glory on June 23, probably due to the plant stage in which susceptibility to oxidant did not develop. The damage to spinach appeared in the area where oxidant dose was more than 50 pphm-hr with some exceptions. No remarkable damage was observed on July 30. Some consideration was given to the relationship of damage to morning glory with the oxidant monthly dose. Average percentage of damaged area of leaves better represents the cumulative damage than does the percentage of damaged leaves. On the average, Scarlet O'Hara was more susceptible to oxidant than the Violet variety.
Source: T

#666

Sawada, T., G. Mori, I. Nouchi, T. Odaira, and T. Komeiji. "Kokagaku sumogu no eikyo to omowareru shokubutsu no higai Tokyo ni tsuite." (Injury by photochemical smog, as observed and reflected on plants in Tokyo). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):139 (1971).

The injuries of plants in Tokyo due to high concentrations of oxidants in the air were investigated. Green leaves of zelkova trees fell with part of them showing chlorosis and necrosis. Some of the leaves also showed dehydration and loss of softness. Welsh onions showed discoloration of the leaves to a gray-green, and then they turned to gray after two to three days. At even higher oxidant concentration, the leaves drooped remarkably. Spot discoloration of chlorophyll on leaves of many vegetables was also found. The symptoms of both the zelkova tree and the vegetables occurred more often during the period from June to September. However, there were differences between the resistances of the vegetables to the photochemical smog.
Source: 1

#1748
Sawada, Tadashi and Toshio Odaira. "Tokyo-to ni okeru taikiosen ni yoru shokubutsu higai no genjo." (The present state of plant damage in Tokyo by air pollution). Shokubutsu Boeki (Plant Prot.), 27(6):241-244 (June 1973).

Secondary pollutants such as oxidants are causing increased plant damage in urban areas. Photochemical smog occurred for the first time in Tokyo on July 18, 1970 when high school girls suffered respiratory symptoms and plant damge occurred, including defoliation of the zelkova trees in rural areas of Tokyo. Smog damage is especially noticeable on zelkova trees, poplar, platanus, ginkgo, and Japanese hibiscus--it causes untimely defoliation or discoloration, dehydration, and curling of leaves. Damage is also severe and quick in green vegetables such as spinach, Japanese radish, salting greens, and leeks, The investigation results did not necessarily coincide with experimental results for ozone. Oxidants were judged to be the major cause of plant damage in the Tokyo area. Sulfur dioxide pollution, effects on plants, and its use as an indicator of polution is mentioned.
Source: 1

#1743
Sawada, T., T. Ohashi, I. Nouchi, and T. Odaira. "Asagao no okishidanto shihyosei no tsuite-A." (On morning glory as an oxidant indicator (A)). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, 640-645 (March 1974).

Seedlings of Scarlet O Hara variety of morning glory having four leaves were transplanted in a residential area about 20 Km west of the center of Tokyo, and the existence of damage, the total number of leaves, the number of damaged leaves, the position of damaged leaves, and the degree of damage were observed daily at 8-9 am from June to September 1973. Specific symptoms of oxidant change to the leaves of morning glory were dependent on the degree of exposure to oxidant: chlorosis with relatively light exposure, bleached spots with moderate exposure, and necrosis with higher exposure of grown leaves to ozone as well as silvering of the lower surface probably due to exposure to peroxyactyl nitrate. Although chlorosis, bleached spots, and necrosis were recognized on leaves artificially exposed to ozone, the silvering is not yet identified experimentally as due to PAN. There are cases when only bleached spots appear or when both bleached spots and necrotic spots appear simultaneously after one exposure. The damage due to oxidant was more serious on lower leaves. Symptoms such as bleached spots and necrotic spots appeared in all of the following environmental conditions: oxidant concentration more than 15 pphm, continuous exposure for 2 hr to oxidant concentrations more than 15 pphm, and daily dose (9 am-6 pm) of oxidant at more than 80 pphm-hr.
Source: 1

#1745

Sawada, T., T. Ohashi, I. Nouchi, and T. Odaira. "Asagao no okishidanto shihyo-sei ni tsuite-B." (On morning glory as an oxidant indicator (B)). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, 645-654 (March 1974).

Seventy-four varieties of about 150 strains of morning glory were transplanted to a garden in the campus of Ibaragi Univ. (45 km NE of Tokyo), and the growth states, symptoms (kind and degree), and the amount of damage due to oxidant were observed as well as the status of oxidant at the nearest monitoring point. After investigating the suitability of varieties as oxidant indicators, the 30 varieties were screened and classified as to susceptibility to oxidant. The varieties of 11 strains were relatively susceptible to oxidant. Eight varieties of 10 strains were lower in susceptibility. On 8 varieties of 10 strains a specific chlorosis appeared. Anthocyan appeared conspicuously on plants with purple stems, but not on plants with green stems. Damage had previously appeared on the Scarlet O Hara variety when oxidant dose was over 60-80 pphm-hr, however, in the present investigation no damage appeared on Scarlet O Hara in spite of at least 5 days with oxidant dose higher than 60 pphm-hr and at least 2 days at more than 80 pphm-hr. This is apparently due to differences between strains of Scarlet O Hara.
Source: 1

#1749

Sawamura, S., and S. Kobori. "Aryusan gasu no seitai shokubutsu saibo ni oyobosu sayo (1). " (Effects of sulfurous acid gases on plant cells in vivo (I)). Text in Japanese. Utsunomiya Daigaku Kyoikugakubu Kiyo (Dainibu) (Bull. Utsunomiya Univ. (Sect.2)), 22:31-36 (1972).

The acute effect of sulfur dioxide on plant cells was studied using Commelina communis leaves. An excised segment of Commelina epidermis, treated with an agar plate containing 2 or 4% surcrose, was cultured in a moist chamber on the first day of the experiment. On the second day, the agar layer on the cover glass was stripped and the middle part of the tissue segment remaining on the glass was exposed to the rapid flow of SO_2 for 5 sec. Exposed cell groups showed hard alterations of protoplasm and its severe coagulation. In the cell death of outermost part, granules and crystals exhibited Brownian movement in the protoplasm converted to liquid. After treatment with the gas, some cells showing slow protoplasmic streaming in normal living cells were dead within 3 days. The liquefaction of protoplasm and the weakness of cells may be connected with the chronic toxicant action of SO_2. Related experiments with leaves of Tradescantia, Begonia Evansiana, and Saxilfraga stlonifera are described.
Source: 1

#1750
Scheffer, Fritz, Eberhard Przemeck, and Werner Wilms. "Untersuchungen uber den Einfluss von Zementofen-Flugstaub auf Boden und Pflanze." (Investigations pertaining to the influence of airborne dust coming from cement furnaces on soil and plants). Staub (Duesseldorf), 21(6):251-254 (1961).

The effects of cement furnace dusts on plants and soil were investigated. Barley, German weidel grass, sugar beets, and Hungarian red clover were used in the experiments. No damage to the plants was observed over a two-year period. The soil pH increased, and during the second year, when the cement dust had a high potassium content, its lactate soluble K20 content increased with increasing dust quantity. Barley showed a small decrease in yield with increasing dust. For the German weidel grass and Hungarian red clover, the increased alkalinity caused by the dusting process had a favorable effect on the mass yield. Sugar beets also showed an increased mass yield, and the plant contents remained unchanged. The possibility exists of an indirect influence on plant yield and the substances contained in the plants by the soil and by changes in the soil reaction and nutrient. Under certain circumstances this may lead to impairment of plant production. The dust sedimented in the vicinity of cement factories appears to have no immediate danger for plants as long as its influence can be counteracted at the right time. The best counteraction can be achieved by the application of physiologically acid fertilization.
Source: 1

#134
Schlesinger, W. H., and W. A. Reiners. "Deposition of water and cations on artifical foliar collectors in fir krummholz of New England mountains." Ecology, 55:378-386 (1974).

Atmospheric depositions of water, calcium, magnesium, sodium, potassium, and lead were measured in an Abies balsamea krummholz ecosystem in New Hampshire, U.S.A. Two types of collectors were used. Open buckets captured rainout, washout, and sedimentation (bulk precipitation) while buckets with attached artifical conifer foliage collected intercepted aerosols and cloud droplets as well as bulk precipitation. Water catchment averaged 4.5 times greater in the foliar collectors than in open buckets, and calcium, magnesium, sodium, potassium, and lead deposition averaged 8.3, 6.0, 4.9, 5.7, and 5.5 times greater, respectively, in the foliar collectors. Most of the increases in foliar collectors were due to higher volume catchment but some concentration enrichment through interception was also contributory. These data cannot be extrapolated to elemental deposition per unit area without correcting capture efficiency of collectors to that of natural vegetation. These data do strongly suggest, however, that in areas of high wind and frequent exposure to clouds or fog, such as in montane areas of New England, measurements of total elemental deposition require an evaluation of interception as well as bulk precipitation.
Source: 7

The effects of industrial emissions on the resistance of certain tree species to insects and fungi were examined with respect to the eventual application of this data to the reconstruction of forest areas in industrial areas. Insect pests commonly associated with pines, spruce trees, larches, firs, hemlock, thuja, birches, alders, oaks, beeches, maples, sycamores, ash trees, lindens, elms, aspens, poplars, willows and other common forest species were reviewed and the resistance of these species to industrial emissions was considered.
Source: 1

#1752
Schnaider, Zbigniew and Zbigniew Sierpinski. "Probleme des Forstschutzes im Oberschlesischen Industriebezirk." (Forest conservation problems in the upper Silesian industrial region). Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p. 45-62 (Sept 9-14, 1968).

Sulfur dioxide and dust levels in 1967 in woods of the Upper Silesian industrial region were measured at 0.9-1.318, 0.466-1.380, and 0.372 mg SO2/100 sq cm at distances of 1,2.5-3 and 6 km respectively from the emission source, and 0.553-0.667, 0.311-0.824, and 0.290 g dust/sq m respectively from the same distances. These levels of pollution caused a general decrease of productivity of the forests and a degradation of tree stands during the past decade, including pest infestation. The greater part of these forests are in such condition that their continued cultivation is senseless regardless of age and a replacement of these stands by hardier and more resistant species and strains like Quercus borealis, Robina pseudoacacia, Platanus, Thuja, Tsuja, Tsuga canadensis, Pinus nigra and Lairix leptolepis is recommended. Because of the close connection between pollution and susceptibility to pest infestation not only resistance to chemical pollutants but also to potential pest infestation should be considered when making a choice of tree varieties as a replacement for the current susceptible species.
Source: 1

#1754
Schnappinger, M.G., Jr., D.C. Martens and C.O. Plank. "Zinc availability as influenced by application of fly ash to soil." Environ. Sci. Technol., 9(3):258-261 (March 1975).

The effect of fly ash on the availability of soil zinc was studied using six of 15 samples collected from power plants located in nine states. The fly ash ranged from 12.9-378.2 ppm in total zinc and from 1.5-93.0 ppm in acid extractable zinc. Incorporation of an acidic fly ash sample into Frederick silt loam and Westmoreland silty clay loam corrected zinc deficiency of cornplants grown in the greenhouse on the two soils. Dry weight and zinc uptake data indicated approximately equal availability of zinc in

#1751

Schmidt, H. "Beobachtung uber Gasschaden an Obstbaumen." (Observation of coal gas damage to fruit trees). Deut. Baumschule, 3:10-12 (1951).

The effects of chlorine gases, resulting from coal combustion, on vegetables and fruit trees are discussed. Damage to spinach, lettuce, endives, rhubarb, onions, peas, and cauliflower was observed in all cases. This damage resulted in a discoloration of the leaves until they were withered and brown. The vegetable plants recuperated according to the degree of damage especially when there was sufficient moisture. String beans, red beans, cabbage, and brussel sprouts were also heavily damaged during the fall of 1950. It was found that among the fruit trees the apple is the most sensitive. The leaves began to shrink, showed a dull pale green discoloration, and fell off within a short period of time. Depending on the degree of damage, loss of leaves was followed by a loss of young fruits. Well growing pear species were less damaged than the weaker growing species. Peaches and apricots lost their leaves during the spring after a pale green discoloration, and also lost some fruit. Among the berry-bearing fruits, gooseberries lost leaves and fruit, currants showed brown coloration of the leaves, and raspberries and blackberries suffered no damage. These observations indicate that considerable damage can be inflicted on cultured plants by industrial waste gases.
Source: 1

#668

Schmitz, Dumont, W. "Versuche ueber die Finwirkung von Fluorwasserstoff in der Atmosphaere auf Pflanzen." (Tests on the effects of atmospheric hydrofluoric acid on plants). Tharandter Forstl. Jahr., 46:50-57 (1896).

Smoke box tests were carried out on 3-year old trees to investigate the effects of hydrofluoric acid introduced in the form of NaHF in two different concentrations. Smoke was applied once a day. At a concentration of 1:10,000, spruce showed a much lower resistance than oak, the most resistant, and Norway maple. Ashes from oak leaves treated with hydrofluoric acid gas outdoors contained 0.125% fluor while those from untreated leaves were free of fluor. Applications of smoke with hydrofluoric acid in a concentration of 1:300,000 revealed the harmfulness of this substance to plants, even in this low concentration, when the exposure is for a period. Oak and Norway maple again showed higher resistance than spruce. Brown and red discoloration of the leaves and needles are the most conspicuous symptoms of fluorine damage.
Source: 1

#1753

Schnaider, Zbigniew. "Podatnosc na zery owadow poszczegolnych gatunkow drzew i ich przydatnosci do przebudowy drzewostanow w rejonach przemyslowych." (Susceptibility of certain tree genera to being devoured by insects and their usefulness for reconstruction of forest areas in industrial regions). Ministry of Forestry and Timber, Cracow (Poland), Commission for Economic Forestry and Recultivation Affairs in Industrial Regions, 4(25):105-121 (1971).

the acidic fly ash and in hydrated zinc sulfate. Application of fly ash samples with relatively high titratable alkalinities decreased the dry weight of corn plants grown in the greenhouse on the Frederick soil. The decrease was attributed partly to accentuation of zinc deficiency at the higher levels of alkalinity established in the soil by application of the fly ash. Thus, the diverse effects of different samples of fly ash on zinc availability should be considered when soils in which plants are to be grown are used for disposal of the material.
Source: 1

#669
Schneider, R.E., and D.C. MacLean. "Relative susceptibility of seven grain sorghum hybrids to hydrogen fluroide." Contrib. Boyce Thompson Inst., 24: 241-243 (1970).

The relative susceptibility to gaseous hydrogen fluoride of seven grain sorghum hybrids of commercial importance in Texas was investigated. Fumigation resulted in necrosis of the plant tips and chlorotic mottle of subtending tissue. Necrosis was generally limited to the second and third youngest leaves. The severity of injury was variable: DeKalb C44C and RS 608 were most resistant to HF-induced necrosis and Northrup King 222A, Pioneer 846, RS 610, RS 625, and RS 671 were more susceptible. There was no relationship between foliar injury and F accumulation.
Source: 1

#670
Schnetzer, H.L., and H. Wenger. "Vegatationsversuche und analytische Arbeit in den Laboratorien." (Vegetation tests and analytical work in the laboratories). Text in German. Chem. Rundschau (Solotburn), 25(15):425-427 (April 1972).

Since the important quantities of refuse from mass-stock farming and the various types of sludges are reused in Swiss agriculture, vegetation tests were carried out by the Swiss center for agricultural chemics in order to examine the compatibility of the matter used as manure. Vegetation tests were also done to investigate the influence of exhaust gases from motor cars, fluoride, and sulfur trioxide on plants. The Swiss research center used an air-conditioned vegetation hall where the tests were made during the whole year. The necessary sun light was simulated by fluorescent strip lamps of 20,000 Lux. Plants to be tested were put into special zinc pots filled with 5 l of mineral soil and were exposed.
Source: 1

#1757

Schoenback, Helfried. "Untersuchungen ueber Vegetationsschaeden in der Umgebung einer Stueckfaerberei." (Studies on vegetation damages around a textile dyeing plant). Berichte aus der Landesanstalt fuer Immissions- und Bodennutzungsschutz des Landes Nordrhein-Westfalen, Rept. 4, 33-78 (1963).

Vegetation damages and growth anomalies occurring around a textile dyeing plant were studied to determine the cause of the damages. Symptomatologic studies revealed such damages as growth anomalies, metamorphoses and concrescences of leaves, anisotropy, and departures from the natural correlations between plant parts. While dicotyledonous plants were primarily affected, damages occurred also in Gymnosperma and Pteridophyta. Tests on cress and other indicator plants identified the causative agent to be Palanil Carrier A, a product used in the adjacent textile dyeing plant. Palanil Carrier A has selective growth regulating properties. Necrosis and other local damages due to Remol TRF, another produce used in the dyeing plant, were also observed.
Source: 1

#1758

Schoenbeck, Helfried. "Die Anwendung der Testpflanzenmethode. Eine Modifikation des Saurerschen Fangpflanzenverfahrens zum Nachweis von Pflanzenschaedigenden Immissionen." (The application of the test plant method. A modification of saurer S plant indicator method for the detection of plant damaging emissions). Polska Akademia Nauki Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland. 313-325 (Sept 1968).

Proof that damage to vegetation by emissions from a zinc smelter was obtained by cultivating identical plants at various distances downwind from the smelter and in an uncontaminated locality. To eliminate differences in soil and other environmental factors holes were made in the ground, lines with plastic to prevent interaction with the surrounding soil, were filled with loamy sand containing 20 mg Zn/100 g soil plus 114. mg Pb/100 g soil (contaminated soil) and 4.0 mg Zn/100 g soil plus 5 mg Pb/100 g soil (normal soils). Both soil types were used side by side in all experimental sites. Summer wheat, beans, oats, and sugar beet were used as experimental plants. Since damage to the control area plants was due only to the contaminated soil, any additional damage in a polluted atmosphere could be ascribed to the effect of atmospheric pollutants. Wheat grain yield at various distances from the smelter was 46-77% lower than the yield in the control area. Other cultures suffered comparably. Generally the damaging effect of the pollution on plant growth was smaller than that of the metal salt pollutants in the soil. The Zn, Pb, and S levels in plant tissues decreased with increasing distance from the zinc smelter.
Source: 1

#1755
Schoenbeck, H. "Nachweis schwermetallhaltiger Immissionen durch ausgewaehlte pflanzliche Indikatoren." (Detection of heavy metal containing immissions through selected plant indicators). Staub, Reinhaltung Luft, 34(6):214-224 (June 1974).

For the detection of heavy metal-containing atmospheric pollutants by existing vegetation, single wild growing trees or bushes are most suitable. The frequently occuring elder was therefore used for determination of the spread of zinc, lead,and cadmium-containing pollutants in the western Ruhr area covering roughly 900 sq. km. From 44 uniformly distributed locations and a further one outside the industrial Ruhr are leaf samples of elder (Sambucus nigra) were taken and analyzed by scripping voltammetry. The normal concentration was considered as exceeded when values of more than 100 ppm Zn, 10 ppm Pb and 0.5 ppm Cd were measured. The results, of which only excerpts are presented, show that the maximum Zn concentrations at 82% of the locations exceeded the normal value, the maximum Cd concentration exceeded the normal value at 40% of the locations and those of lead exceeded the normal value at all locations. Zinc and lead were found to be wide spread long-term emission components, while Cd was found over longer periods of time in the elder samples only at certain points. In the vicinity of a zinc plant certain test plants were grown under standard conditions and the same soil in the direction of the main wind direction with a control patch on the leeward side. In addition, the soil around the zinc plant was used for cultivation of the indicator plants for the purpose of determining the effects of the dust sediments on the plants. Soil polluted by heavy metal emission increased the sensitivity of plants towards atmospheric effects of air pollutants.
Source: 1

#1756
Schoenbeck, H. and H. vanHaut. "Exposure of lichens for the recognition and the evaluation of air pollutants." Assoc. of Official Analytical Chemists; International Union of Pure and Applied Chemistry; the Chemical Inst. of Canada; The Agricultural Inst. of Canada; and the National Research Council of Canada, Int. Symp. Ident. Meas. Environ. Pollut, Ottawa, Ontario, 329-334 (June 14-17, 1971).

The use of lichens for the recognition and the evaluation of air pollutants is described. Both field and fumigation experiments proved that the lichen Parmelia physodes is measurably influenced by sulfur dioxide, hydrogen fluoride, and hydrogen chloride. There was a distinct relationship between the dose of a toxicant and the death rate. Development of methods of exposing these lichens in polluted areas and of determining their reactions made it possible to use these organisms as a biological measuring procedure. The death rate within a certain period of time was used for monitoring air pollution in both small and large areas. The use of lichens as indicators for toxicants in air can lead to a simple and inexpensive method of monitoring air pollutants.
Source: 1

#671
Schoenbeck, H. and H. van Haut. "Messung von Luftverunreinigungen mit Hilfe pflanzlicher Organismen." (Measuring air pollutants by means of indicator plants). TERPLAN-Statni ustav prouzemni planovani, Ustav krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiny Sbornik Z Mezinarodni Konference, Prague, Czechoslovakia, p.30-38 (1971).

Possibilities of the use of plants as bionindicators of air pollution in general and air pollution components in particular are described. Visible and physiological changes, accumulation of air pollutants in the plant organism, and changes in the composition of phytoassociations are among the principal consequences of exposure to air pollutants, making the use of plants as bionindicators possible. Plants can be used in exposure chamber tests in which plants are grown under identical conditions with filtered or unfiltered air. The test plant method uses plants grown under identical conditions within and beyond the emission-affected area. When used in such tests, Brassica oleracea acephala is suitable, apart from reflecting the overall pollution level, for the detection and accumulation of polycyclic aromatic hydrocarbons along with lead, fluorine, and chlorine. The poisoning hazards faced by animals can be determined by grass patches in fluorine emission areas. Epiphytic lichens and mosses were found to be true indicators of air pollution, and even of short-term pollution episodes. The longitudinal growth of the Lepidium sativum roots was found suitable for the detection of pollutants with an auxinic effect.
Source: 1

#1759
Schofield, Edmund. "Some considerations on the possible effects of local and global sources of air pollution on lichens grazed by reindeer and caribou." Alaska Univ., Fairbanks, p. 90-94 (1972).

Considerable evidence shows that local sources of air pollution eliminate most lichens from the immediate vicinities of urban and industrialized areas in temperate regions. Pollutants such as sulfur dioxide appear to be transported hundred of kilometers from Britian and central Europe to Scandinavia. While there appear to be no reliable data or observations that link pollutants transported on a global scale to the deterioration of lichens there (primarily because the possibility has not been persued), all of the ingrediants necessary for lichen damage are present. Scattered comments and circumstantial evidence in the literature suggest that global pollution--in addition to local pollution--will adversely affect lichens grazed by reindeer and caribou. The accelerated industrialization of the Arctic makes this possibility of more than academic interest. The effects of SO2 on algal chlorophyll, osmotic effects on lichens, effects of temperature inversions and ice fogs on lichens, global versus local pollution,and possible consequences for reindeer and caribou in the Arctic are discussed.
Source: 1

#1760
Schofield, Edmund and Wayne L. Hamilton. "Probable damage to tundra biota through sulphur dioxide destruction of lichens." Biol. Conserv., 2(4): 278-280 (July 1970).

Lichens, particularly the fruticose members of the genus Cladonia, are important components of many arctic ecosystems and form a principle component of the forage of indigenous caribou. The Nanamiut Eskimos, in turn, depend on the caribou for food, clothing, and other necessities. The lichens, particularly the caribou forage lichens, are extremely sensitive to sulfur dioxide. Atmospheric pollution from recent oilfield development in Arctic North America therefore seems likely to eliminate lichens from large areas. This threat is intensified by the climatic conditions on the Arctic Slope which make air pollution more serious there than in most other places. Probably future oilfield development in Greenland and the Soviet Union indicates that sulfur dioxide pollution will become an increasingly serious threat to remaining arctic ecosystems. Uncontrolled burning of crude oil, fuel oil, and natural gas should be avoided and adequate sulfur extraction facilities should be installed to protect these ecosystems.
Source: 1

#672
Scholl, G. "Einfluss phytotoxischer Immissiones auf das Wachstum landwirtschaftlicher und gaertnerischen Kulturen." (Influence of phytotoxic emissions on the growth of horticultural and agricultural crops.). Text in German. Landwirt. Forsch. Sondern., 19:166-176 (1965).

The effect of emissions from a metallurgical plant, including sulfur dioxide and fluorine derivatives, on plant growth was investigated during a three-year period. The 12 month average SO_2 content ranged from 0.24 to 0.30 mg/cu m above the two experimental lots. The damaging effects were focused on the gases and consisted in color alteration and necrosis. Plant growth and yield effects varied according the climatic conditions, species, and stage of growth. Winter rye and leek appeared to be the most emission-resistant species. Highest yield losses were produced in certain bean species, spinach, and summer barley. Barley accumulated the highest amount of sulfur which increased from 0.54 to 0.83% (dry matter) in the leaves at the end of the third year of the experimental period. Fluorine content ranged from 3.0 (spinach) to 26.2 (summer barley) mg/100 g dry matter during the second year of the experiment.
Source: 1

#863

Scholl, G. "Ein Beitrag zum Problem der Erkennung von immissionsbedingten Pflanzenschadigungen." (A contribution to the recognition problem of plant damage induced by immissions). Schriftenreihe Landesanstalt Immissions- und Bodennutzungsschutz Lands Nordrhein-Westfalen (Essen), 73-79 (1969).

Turnips, barley, and trees growing on farms bordering a fertilizer manufacturing plant and a refinery exhibited disturbed growth, partial defoliation, and leaf discoloration. When sulfur dioxide emissions in the area were determined to be of a magnitude sufficient to cause plant damage, the question of emission effect on the fertility of soil was clarified in corresponding soil investigations. Soil analyses revealed a 30-50% decrease in 'root soluble' nutrients, significantly lower pH values, and a decreased base activity that correlated with an abnormally high sulfate content in the soil as well as in spring water and rivers. These results show that the acidifying action of sulfur dioxide can have an adverse influence on the alkaline balance of light soil.
Source: 1

#358

Scholl, G. "Die Immissionsrate von fluor in Pflanzen als Masstab fuer eine Immissionsbegrenzung." (Immission rate of fluorine in plants as a quantitative basis for an immission limitation). VDI (Ver. Deut. Ingr) Ber., 164:39-45 (1971).

The accumulation of fluorine in organs of plants which grow above ground, such as leaves and needles, represents an important criterion for the evaluation of the effect of phytotoxic fluorine compounds on vegetation. The quantity of fluorine absorbed depends on the sensitiveness and absorption capacity of the plants, and on the fluorine concentration in the surrounding air. Fluorine concentrations of less than 0.5 micrograms/cu m air can already cause an accumulation in the course of one growth period of more than 50 mg fluorine in 100 g dry leaf substance. With increasing concentrations of hydrofluoric acid in the air, enrichment of fluorine occurs in tomato leaves, grasses, clover, and other fodder plants. Based on the close connection between fluorine concentrations in the fodder and the fluoric intoxication of cattle, standards of fodder quality are suggested for the protection of domestic animals, particularly cattle and sheep. Since the fluorine content fluctuates with the seasons, a maximum yearly average of 4.0 mg fluorine in 100 g dry substance (DS) based on one analysis per month is proposed, maximum 6.0 mg F/100g DS within two consecutive months, and maximum 8.0 mg f/100 G DS in any individual month. Standardized grass cultures, grown in portable containers under controlled conditions of seed and soil have been developed as measuring devices for fluorine air polluon. They are being exposed to the open air for 14 days, then washed, dried, and pulverized to obtain the required condition for analysis of the fluor content.
Source: 1

#1761

Scholl, G. "Ein Biologisches Verfahren aum Nachweis von Fluorverbindungen in Immissionen." [Biological method of determining fluorine compounds in atmospheric pollution]. Mitt. Forst. Bundesvers.,(Essen), 97:255-269 (1972).

A grass culture method for determining the origin and distribution of fluorine compounds in the air has recently been developed. With this method, the accumulation of fluorine in the test plants is used as the measured value. The only plants which are suitable are those which can accumulate the toxic substance in large amounts without showing visible external symptoms of damage or a depression in growth. Certain grasses, such as Lolium multiflorum and L. perenne, are relatively insensitive to fluorine compounds in the air. These indicator plants are placed for a defined period in a standardized growth substrate with comparable nutrient and water supplies in the vicinity of a pollution source. The plant samples obtained at the end of the exposure period are analyzed for their fluorine content. On the basis of the fluorine values obtained (m mg/100 g dry matter), it is possible to assess the origin and distribution of fluorine compounds in the air and to make a prediction of the fluorine hazard to grazing cattle. Details of the method and the results of some practical field investigations are reported.
Source: 1

#1762

Scholl, G. "Ermittlung ueber die belastung der vegetation durch schwemetalle in verschiedenen immissionsgebieten." [Determination of the pollution of the vegetation by heavy metals in various emission areas]. Staub, Reinhaltung Luft (Germany), 34(3):89-92 (March 1974).

The intake of zinc, lead, and cadmium by grass cultures in unpolluted areas grown under standard conditions was studied. In an area of about 1000 sq km in the Western Ruhr Area, 41 measuring points were erected spaced 4.95 km apart. In addition, plant samples were taken in a 10 sq km area in the vicinity of a zinc plant. Along the Autobahn, measurements of the zinc, lead, and cadmium concentration in the vegetation were taken in distances of 1, 15, 25, 50 and 100 m. The results revealed that in the three emission areas, the heavy metal pollution of the vegetation varied greatly and in part reached exceptionally high values. The intake rates from emissions alone as well as from combined intake composed of heavy metals in the air and in the soil are listed in tables. Total intake rates between 66.2 and 147.1 ppm zinc, 8.3 and 35.5 ppm lead, and 0.41 and 1.15 ppm cadmium were measured in the Western Ruhr. The highest concentrations were found in the urban and industrial areas of the South between Rheinberg and Bochum. In the central and Northern Ruhr section with primarily a rural character, the total intake was hardly higher than that of the controls from nonpolluted areas. In the vicinity of the zinc plant, significantly higher heavy metal concentrations were also measured. The zinc concentrations were 181 to 10.7 ppm, the lead concentrations were 12-41 ppm, and the cadmium concentrations were 0.1 to 10.4 ppm. The zinc and cadmium enrichment in the vegetation was highest close to the emission source and dropped with increasing distance at first rapidly, then more slowly. In vegetation samples taken near the highway, a high enrichment of lead, and to a lesser extent of zinc and cadmium, was found at the edge of the highway. Here 74.4 ppm lead, 107.7 ppm Zn, and 0.5 ppm Cd were measured in the dry mass. With increasing distance from the highway, the lead concentration dropped, at first steeply, then slowly, and was down to 15 ppm in a distance of 100 m. The Cd intake was already markedly lower at 15 m, the Zn intake at 25 m.
Source: 1

#864

Schonbach, H., H.G. Dassler, H. Enderlein, E. Bellmann, and W. Kastner. "Ueber den unterschiedlichen Einfluss von Schwefeldioxid auf die Nadein verschiedener Zjahriger Larchenkreuzungen. 10. Veroffentlichung der Arbeitsgemeinschaft fuer forstliche Rauchschadenforschung Tharandt." (On the different influences of sulfur dioxide on the needles of various two year old larch hybrids. 10. Publication of the study committee for flue gas research in forestry, Tharandt). Study Committee for Flue Gas Research in Forestry, Tharandt (West Germany), Publ 10, p. 312-316 (1964).

Research involving the development of sulfur dioxide-resistant coniferous trees is described. The larch tree was selected for breeding, since it looses its needles in the winter, similar to deciduous trees, which are more resistant to SO2. Two-year-old larches developed from directed cross-pollination, partly from European larches and partly from the Japaneses larch, were exposed in a controlled atmosphere greenhouse for periods of 10 to 50 hours to SO2 concentrations of 0.34 to 0.73 ppm. Damage evaluation was standarized by a needle-damage scale of 1-10. On the average, all hybrid trees exhibited a greater resistance to SO2 than the pure trees. Hybrids from two different strains of Japanese larch had significantly different responses. The degree of resistance of the various breeds is based mostly on genetics. This indicates that the development of a resistant strain from direct cross-pollination is a promising possibility.
Source: 1

#234

Schucht, F., H. H. Baetge, and M. Dueker. "Ueber bodenkundliche aufnahmen im rauchschadengebiet der Unterharzer Huettenwerke Oker." [Soil analyses in the smoke damaged area of the metallurgical plant Oker in Unterharz]. Landwirt. Jahrb., 76:51-98 (1932).

The metallurgical plants in Oker primarily emit sulfur dioxide, nitrous acid, and carbon dioxide. The effect of these emissions on the soil was determined by taking soil samples, profile samples, and individual samples at 42 points. The area has primarily clay soil interspersed with sand and gravel. The soil was studied to determine the absorption, permeability, and coherence. Hydrochloric acid extracts were analyzed to determine if changes had occurred because of the pollutants. With prevailing west winds, an extensive area receives the emissions from the metallurgical plants. In all samples, an enrichment of the sulfates (in the form of calcium sulfate) was found. This cannot cause soil damage since the quantities are too small. With the influence of SO2 and CO2, the soil loses its alkalinity. However, the soil contained so much calcium the SO2 became bound. Iron sulfates, which form only without alkalinity, could not be determined. Within a belt of one to one and one half km wide, hardly anything grew. This belt was followed by a zone (2 km from the emission source) where the root crops were still heavily damaged. Between three and three and one half km from the emission source, the effect of the pollutants was weak. Also, the most copper, lead, zinc, and arsenic were found in the soil; they are mostly insoluble, and thus are harmless compounds.
Source: 1

#58
Schuck, E. A., and J. K. Lock. "Relationship of automotive lead particulates to certain consumer crops." (Presented at the Symposium on Air Conservation and Lead, Division of Water, Air, and Waste Chemistry, 157th National Meeting, American Chemical Society, Minneapolis, April 1969.) Environ. Sci. Technol., 4(4):324-330 (April 1970).

The colorimetric dithizone technique was used to analyze cauliflower, tomatoes, cabbage, strawberries, and valencia oranges for their lead content. The soil, water, and air in contact with the crops were also analyzed for lead. The combined findings from the edible portion of four of the five crops strongly suggest that automotive lead particulates are not absorbed. They existrather as a topical dust coating of which at least 50% can be removed by simple water washing. Neither did these crops show any inclination to absorb lead through their root systems. Similar conclusions relative to strawberries cannot be drawn, except by analogy to the other crops. In spite of growing near heavily traveled highways, i, e., up to 50,000 vehicles a day, the amount of lead associated with the five crops in an untreated state was never greater than one microgram of Pb per gram of fresh weight. The average Pb concentration of the entire crop areas studied was one or two orders of magnitude less than one microgram of Pb per gram of fresh weight.
Source: 1

#1763
Seaward, M.R.D. "Lichen ecology of the Scunthorpe Heathlands. I. Mineral accumulation." Lichenologist, 5:423-433 (1973).

An investigation into the distributional and ecological characteristics of the terricolous lichen flora of the Scunthorpe Heathlands is described. The Risby Warren area was especially studied, because there is a noticeable terricolous lichen desert and distinctive zonation of lichen communities, each of which incorporates Peltigera rufescens. Peltigera rufescens appeared to be quite tolerant of air pollution in this region, and occurred in sufficient quantities for periodic sampling; this proved valuable for determination of the sulfur, chromium, copper, iron, lead, manganese, and nickel content of the thalli along a 780 m transect. Frequency assessments, together with these element determinations, revealed sharp qualitative and quantitative improvements in the lichen flora with increasing distance from the pollution sources. The stable lichen pattern, together with the mineral accumulation measurements, was indicative of a pollution dome effect operating to a distance of approximately 3 km. Within 100-200 m of this critical distance, lichen material had a pronounced metallic accumulation; the latter was compared with urban and herbarium material. The possible use of lichens for the sampling of ambient environmental conditions is discussed.
Source: 1

#1764
The Section for Environmental Protection, Ota Ward, Tokyo. "Ota-ku Shokubutsu Eikyo Chosa Hokokusho -Chukan Hokoku." (Interim report of the survey on the effects on plants (of air pollution)). 101 p. (March 1974).

Toxic tolerances of trees and acute injury of morning glory by air pollution are investigated. The growth and health of Zelkova serrata, Poplar, Ginkgo Biloba, Ligustrum japonicum, and Quercus myrsinaefolia, which were transplanted in 1972 to eight public gardens in Ota Ward, were examined. A local difference in the growth of Zelkova serrata was notices, and those planted near Tokyo Bay were inferior. No local difference was observed of the growth of G.B., L. j., and Poplar. The growth of Quercus myrsinaefolia was generally bad. The state of injuries was not as severe as the 1972 investigation. The acute injuries of morning glory transplanted in the above mentioned eight public gardens indicated air pollution all over the ward, no local differences of air pollution, a comparison of the injuries between the trees and morning glory was not possible.
Source: 1

#273
Sehmel, G.A. and F. D. Lloyd. "Influence of soil resuspension on the airborne particle size distribution." In: Pacific Northwest Laboratory Annual Report for 1972 to USAEC Division of Biomedical and Environmental Research. Volume II: Physical Sciences, Part I. Atmospheric Northwest Labs., p. 1-5 (April, 1973).

The airborne particle size distribution function of resuspended soil was determined as a function of particle diameters from 1 to 230 micron and sampling heights from 0.3 to 30 m. An apparent lower limit was determined for the size distribution function. Soil resuspension can cause relatively high soil injection rates into the atmosphere which increase the magnitude of the size distribution function above the lower limit. The soil resuspension rates are a direct function of the hours of high wind speed occurring during dusty time periods. However, the resuspension rates must also be a function of the persistence of these high winds since less resuspension occurs for the same total hours of high winds when these hours are accumulated over a longer time period.
Source: 1

#1765
Seibel, W., H. D. Ocker, and W. Nierle. "Heavy metals in grains and grain products." (Schwermetalle in Getreide und Getreideprodukten). Text in German. Deut. Lebensm. Rundsch., 70(9):315-318 (1974).

The mercury content in domestic cereals (wheat and rye) was measured and varied between 1 and 20 ppb. Regional differences in mercury content could not be ascertained, and no firm differences between wheat and rye were found. The rather low Hg concentrations were in agreement with recent investigations made in Canada, England, America, and West Germany. The cereal's lead content was much more dependent on its site. The nearness of industrial facilities affected the lead content. Lead concentrations of 0.1-0.2 ppm were found in domestic cereals. The maximum allowable figure is 0.3 ppm Pb for

cereal products. At 250 m from the highway Ruhrgebiet-Hannover, the measured lead concentration in grain was 0.15 ppm; directly next to the highway the concentrations were 0.40 ppm. At 1 km from a zinc plant, a lead concentration of 1.5 ppm was measured in corn. These concentrations were exceptions. Both heavy metals accumulated in the outer layers of the cereal grain. Milling yielded flours of lower heavy metal concentrations, with after-products, particularly brans, having considerably higher concentrations. Dry husking eliminated about half of the heavy metals in the original cereal; wet cleaning had practically no effect. Cadmium appeared to be well accumulated in the outer layers of the cereal grain. It can therefore be expected that a considerable portion of this metal will also be removed with the bran during the milling process.
Source: 1

#959
Seiler, W. and C. Junge. "Carbon monoxide in the atmosphere." J. Geophys. Res., 75:2217-2226 (1970).

A comprehensive study of the global distribution of atmospheric CO is described. The essential results can be listed as follows: (1) In the upper troposphere of the northern hemisphere, the CO mixing ratio varies between 0.10 and 0.15 ppm, with few exceptions. (2) In the planetary boundary layer over the North Atlantic and at high index situations over western Europe, the CO concentrations range from 0.16 to 0.30 ppm if local sources are avoided. (3) Mid-tropospheric data from the subtropics show no marked difference between the two hemispheres, which implies (at least for the sourthern hemisphere) the presence of important natural CO sources. (4) Surface waters of the Atlantic Ocean from 10°S to 60°N at 30°W have CO concentrations 10 to 40 times higher than the atmospheric equilibrium values. Large portions of the oceans appear to act as an important source for atmospheric CO. (5) Measurements in the tropopause region of the northern hemisphere show rapid decrease of CO above the tropopause. It appears that the stratosphere is the major sink for tropospheric CO.
Source: 5

#958
Seim, E. C. "Sulfur dioxide adsorption by soil." Univ. of Minnesota, Ph.D Thesis (1970).

Previous research in the area of sulfur in the soil and atmosphere has shown that absorption of SO_2 by soil does occur. Little information however is available on the specificity, magnitude, and mechanism of the absorption process. The objectives of this study were to measure the absorption of five Minnesota soils of varying characteristics and to relate those characteristics to the ability of the soils to absorb sulfur dioxide.

The study was conducted in the laboratory where the soils were exposed to a constant flow of air containing SO_2 in a plexiga chamber. Sulfur dioxide in the air stream was measured by absorbing the SO_2 in potassium tetrachloromercurate and analyzed spectrophotometrically with p-aminoazobenzene. The exposed soils were separated into 2 cm depth interval zones and analyzed for water soluble, adsorbed and organically bound sulfur. Water and organically bound sulfur was determined by the reduction and blue color development method of Johnson and Nishita. Sulfur extracted by $CaCl_2$ and $Ca(H_2PO4)_2$ was determined turbidimetrically.

The soils utilized in the study were Adolph loam, Dorset sandy loam, Fayette silt, Kittson clay loam and Truman clay loam. Other material testes were glass beads and distilled H_2O. Sulfur dioxide concentration ranged from 0.75 to 5250 ug SO_2/1.

Significant absorption of SO_2 occurred when SO_2 laden air was passed over samples of Fayette silt, Adolph loam, Dorset sandy loam, Kittson clay loam and Truman clay loam. Significant amounts of SO_2 were absorbed by dry and moist soil. Greatest absorption occurred in the 0-2 cm layer of soil and virtually all the absorption took place in the upper 4 cm of exposed soils. Removal of SO_2 from the air stream ranged from 61-100% of the incoming SO_2 concentration. Sulfur dioxide was not found in the exposed soil but large increases in sulfate sulfur were obtained. The recovery of the SO_2 as sulfate by extracting the soil with water, $CaCl_2$, $Ca(H_2PO_4)2$ and $NaHCO_3$ accounted for 64-100% of the SO_2 applied. Greatest amounts were extracted with $NaHCO_3$ solution. The $CaCl_2$ generally accounted for approximately 50% of the absorbed sulfur but on occasion water extractable sulfur exceeded $CaCl_2$ or $Ca(H_2PO_4)_2$ extractable sulfur. Although all soils absorbed sulfur when exposed separately, absorption was not uniform when the soils were exposed simultaneously and the soil initially highest in sulfur, the Adolph, had the lowest relative increase in sulfur as a result of the exposure. The deposition velocity, V_g, averaged 0.2 cm/sec and was relatively constant for all the soils, SO_2 concentrations and moisture levels tested. The results indicate that the soil can absorb considerable amounts of sulfur dioxide from the atmosphere and must be playing a role as an anti-pollution agent as it becomes a sulfur sink.
Source: 5

#1251
Seki, T., K. Abe, H. Hoshikawa, Y. Inoue, N. Kaitani, and S. Kondo. "Jidosha haikigasu ni yoru gairodojo no jukinzokuosen ni tsuite." [On pollution of street soils with heavy metals from automotive exhaust gas]. Koshu Eisei (Public Health), 37(8):561-563 (Aug. 1973).

Heavy metals in the soil near a main street in downtown Sendai city and in the soil of a suburban area with hardly any traffic were measured. Lead concentrations in the main street soil were 164 ppm maximum and 158 ppm average, compared with 24 ppm and 19 ppm, respectively, in the suburban area soil. Lead content of suburban soil was practically the same for both top soil and that at 20 cm depth; lead content of main street soil at 20 cm was 97 ppm, indicating possible lead accumulation. The main street soil also contained two-three times more cadmium, copper, and zinc than suburban soil. No difference in manganese and iron occurred between the two localities. Roadside soil contained 279 ppm of lead on the average while soil 70-100 m away from the road contained 65 ppm. This indicates that lead from automobile exhausts primarily accumulates in the roadside soil.
Source: 1

#1851

Seki, T., S. Abe, H. Hoshikawa, Y. Inoue, N. Mawariya, and M. Kondo. "Taiki osen no shokubutsu ni taisuru eikyo (dai 1 po) Sendai shinai ni okeru gairojuyo no jukinzoku ganryo ni tsuite." (Influence of air pollution on plants, Part I. The content of heavy metals in the leaves of roadside trees in Sendai City). Koshy Eisei (Public Health), 37(9):643-647 (Sept 1973).

The amounts of lead, copper, cadmium, manganese, zinc and iron in and on the leaves of trees near roads were determined in Sendai city. Leaves were sampled in late May, the middle of August, and in late October in center city with heavy traffic and in suburban areas with little traffic. Atomic absorption spectrophotometry was used to determine the metal content of the leaves. Lead and iron increased in August and October from May in all trees, cadmium had the same tendency in all but one type of tree, manganese had the same tendency in all but two tree species, and copper and zinc showed little seasonal fluctuation. Lead concentrations were twice as high in the central area as the suburban area. Mn was little more, Fe was about the same in zelkova trees and was twice as high in ginkgo and Cu, Cd, and Zn had no difference. The amount of metals varied according to the type of leaf surface The total amount of metals was higher in the central area than in the south (15 times higher for Pb, four for Cu, four for Mn, three for Zn, and six for Fe). The amount of Pb in ginkgo leaves and soil correlated.
Source: 1

#1767

Seki, T., Y. Inoue, S. Abe, H. Hoshikawa, N. Mawariya, and S. Kondo. "Taiki osen no shokubutsu ni taisuru eikyo (dai 2 ho) Sendai shinai ni okeru gairoju-yo no io ganryoni tsuite." [Effects of air pollution on plants Part 2, on the sulfur content of leaves of roadside trees in Sendai City]. Koshu Eisei (Public Health), 38(1):50-52 (Jan. 1974).

The sulfur content of different species of roadside tree leaves were determined at 30 points on main roads in urban and suburban Sendai city. Air quality measurements with an automatic sulfur oxides recorder were used to show the variable toxic tolerances and rates of retention of sulfur for different leaves.
Source: 1

#1766

Seki, T., Y. Inoue, K. Abe, H. Hoshikawa, and N. Meguriya. "Taiki osen no shokubutsu ni taisuru eikyo (dai-2-ho), Sendai shinai ni okeru gairojuyo no taiki osen ni yoru eikyo ni tsuite, sono 2 (gairo juyo no io ganryo)." (The effects of air pollution on plants (Part II): The effect of air pollution on leaves of roadside trees in Sendai- No. 2: The sulfur content in leaves). Sendai-shi Eisei Shikensho-ho (Sendai Munic. Rep. Inst. Pub. Health), 4:86-93 (October 1974).

At 30 locations on main artery roads in Sendai and six locations in the suburbs, samples of tree leaves were taken to see the effects of sulfur dioxide on trees. The sulfur contents were investigated in samples of gingko leaves at 17 locations, zelkova at nine locations, Chinese maples at four, tulip

trees at four, and green paulonia at two locations. Samples were taken in late May, mid-August, and late October, 1971. The dusts from the surface of leaves were washed in clean water; the leaves were dried for 3 hr at 60 C, crushed in a bowl, and burned to ashes after adding magnesium. After a proper treatment, sulfuric acid ion was measured by absorption photometry and coverted to sulfur. According to the recovery rate test using the standard sulfuric acid ion liquid, when magnesium nitrate was added, the rate was 94.1-102.4%. The sulfur content in gingko leaves in the city was 0.31-0.41% (average 0.35%) in May, 0.50-0.65% (average 0.57%) in August, and 0.58%-0.80% (average 0.70) in October. The variation coefficients were 8.6, 8.8 and 10% respectively. The averages of three suburban samplings were 0.20% for May, 0.33% for August, and 0.38% for October. The SO_2 concentration between May and October ranged between 0.010-0.055 ppm in the city and 0.006-0.01 ppm in the suburbs. For gingko, regardless of the location, the sulfur content in August and October was 1.6- 2 times over that of May. For paulonia, it was 13 times higher in October than two other times. For other trees, the sulfur level decreased by 30% in August and October. Compared to the levels of sulfur content in trees in Kawasaki and Yokohama business areas, Sendai leaves had 20-30% less sulfur content.
Source: 1

#301
Selezneva, Y. S. and V. M. Drozdova. "The natural background of atmosphere contamination and the composition of precipitation over the territory of the USSR." Sovremennyye Problemy Klimatologii, 1966:292-299 (1966).

Sampling data from over 70 stations were used to construct maps of the distribution of mineral salt impurities in precipitation over the Soviet Union. The average mineralization of precipitation is heterogeneous and varies from 5-10 to 30-35 mg l, although several points exceed the upper value considerably. The geographical changes in the content of the impurities are related to natural zonal changes; for example, the tundra and taiga zones show the purest precipitation, averaging only 10-15 mg/l of dissolved impurities. Variations with change of seasons and distance from marine shorelines are also noted. Precipitation picks up impurities both as they are formed and as they fall through the area beneath the clouds; therefore, the mineralization and composition of precipitation can be used to characterize the contamination of a considerable layer of the atmosphere. The maps show that the most highly contaminated air is in the southern regions of the European part of the USSR and in the Central Asiatic deserts. Calculations based on worldwide coal combustion suggest that sulfur from industrial sources amounts to not over 5% (or, for the entire earth, only about 2%) of the quantity washed out of the atmosphere, and that natural sources (oceans, soil, volcanoes) are considerably more productive. However, this estimate does not eliminate the problem of strong local contamination of the atmosphere.
Source: 1

#302
Selezneva, Y.S., and O.P. Petrenchuk. "On the Removal of Impurities from the Atmosphere by Clouds and Precipitation." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Technical Papers from the Leningrad International Symposium on the Meteorological Aspects of Atmospheric Pollution, Part III. M. Y. Nuttonson (ed.), Vo. 14, Silver Spring, Md., American Institute of Crop Ecology (1972) p. 1-8. Translated from Russian. (Also: Meteorologisheskie Aspekty Zagryazneniya Atmosfery, Glavnoe Upravlenie Gidrometeorologicheskoy Sluzhby Pri Sovete Ministrov USSR, p. 253-259, 1971.)

The chemical composition and total concentration of dissolved and undissolved impurities in precipitation show the degree of pollution of the atmospheric layers through which it falls. Studies made at the Main GeoPhysical Observatory and the compiled maps of distribution of the main impurities in the precipitation showed that in areas distant from industrial plants, under the purest atmospheric conditons the precipitation mineralization amounts to 10-15 mg/l; in areas of appreciable natural and industrial atmospheric pollution, the average precipitation mineralization increases to 30-40 mg/l, and sometimes to higher values. Depending on the mineralization and amount of precipitation, from 5 to 15 tons of substances/sq km fall with precipitation each year over the territory of the USSR, and 20-30 tons or more fall on cities. If the average sulfur concentration in the precipitation is taken to be 2-3 mg/l, precipitation annually removes between 10 to the 8th power and 10 to the 9th power tons of sulfur from the atmosphere. Comparison of these data with industrial discharge data suggests that, on a global scale, the industrial contribution is small and barely amounts to 5% of the impurities supplied by natural sources, such as the ocean, the surface of dry land, and volcanoes. Low stratified clouds, particularly those formed under inversions, accumulate impurities which build up under the inversion layer. Near Dnepropetrovsk, the cloud water mineralization reached 300 mg/l. In the absence of an inversion in this region, the mineralization of water in stratified clouds is 15 mg/l. In the northern regions of the European Territory of Soviet Union and in Western Siberia, the average mineralization of stratified clouds is 9-12 mg/l. The chemical composition of the water from frontal precipitation clouds differs markedly from the stratified and stratocumulus clouds. In evaluating the contribution of clouds to the mineralization of precipitation, the initial value may be taken as 6 mg/l. Methods for calculations of the contribution of cloud and subcloud layers to formation of chemical precipitation composition are presented. In the northern region under pure atmospheric conditions, the chief contribution to precipitation impurities is made by clouds, that is, largely condensation nuclei of marine origin. In southern regions with heavy atmospheric pollution, the predominant process is washing out, and 70-80% of all the impurities are acquired in the subcloud layer.
Source: 1

#673

Sertz, H. "Ueber die Wirkung von Fluorwasserstoff und Fluorsilizium auf die lebende Pflanze." (On the effects of hydrofluoric acid and fluosilicate on living plants). Tharandter Forstl Jahrb., 72:1-13 (1921).

Smokebox tests were carried out on fir and spruce trees to investigate the effects of hydrofluoric acid and fluosilicate in two different concentrations. Both types of trees showed signs of acute poisoning from tests where smoke with a concentration of 1:10,000 of either compound was applied for 1 hr each day. In another test, where the trees were treated with a concentration of 1:250,000 of either compound for three 1-hr periods per day to indicate chronic effects, firs showed higher resistance to fluor than did spruces. Hydrofluoric acid and fluosilicate are extremely harmful to living plants even in very low concentrations. Damage symptoms are similar to those observed in sulfurous acid tests. The material damaged by smoke was analyzed for fluor content.
Source: 1

#114

Servant, J. "Deposition of atmospheric lead particles to natural sources in field experiments." In: Symposium on Atmosphere-Surface Exchange of Particulate and Gaseous Pollutants. Richland. pp. 85-93 (1974).

The deposition of atmospheric lead particles to natural sources is measured in a residential section of Toulouse. This deposition is compared with wet fallout in a pluviometer. Every month over an 8 months period four different tree leaves were analyzed (poplar, elm, platan, and oak).

At this site the ratio of Ph/Pb is higher in the atmosphere than in the soil (0.13 dpm μg^{-1} (Pb) compared to 0.035 dpm μg^{-1} (Pb). It gives the real part of the atmospheric lead deposited on tree leaves.

The atmosphere contribution in the residential section is then compared with that of three forests of rural France.

The accuracy of the index Ph/Pb is shown by a comparison of the specific activity of lead in tree leaves collected in a residential section (Toulouse) with that in a virgin site (Congo, 200 km from Brazzaville). The variations of 2 orders of magnitude of the index in these two sites are similar to the variations expected in the air at ground level.
Source: 7

#113

Servant, J. "Le Bilan hydrometerologique du plomb sur la France (1972-1973). Consideration sur le bilan et importance du depot sec." (The hydrometeorological balance of lead on France (1972-1973). Considerations on the balance and importance of the dry deposit). Conférence Internationale sur les Métaux Rourdo dans l'environement (Toronto), 10 pp. (1975).

The deposition of lead over France is calculated from data gathered in 1972 and 1973. The damp deposit is given from the percentage of lead in rain water of 11 stations. The dry deposit is evaluated from the speed of deposit measured on tree leaves - isolated trees - within the enclosure of the Paul Sabatier University. The value of this deposit is Vd = 0.086 ± 0.022 cm s^{-1} for a period of 7 months. In the balance of the dry deposit, the actual surface of the vegetation (woods: 21 m^2 m^{-2} ; fields: 9 m^2 m^{-2}) is taken into account as well as the effects of variation in wind speed in the foliar mass. It is believed that these parameters are important and have been previously ignored. The damp deposit is only 20% greater than the dry deposit, a total of 9,240 tons per year. The injection of lead into the atmosphere calculated from the combustion of gasoline is only 5,300 tons per year. The possible causes for this difference in the balance are discussed - one of them is probably a greater dispersion of lead in the atmosphere - up to 9,600 tons per year. In conclusion, it seems that the amount of the total deposit (9,240 t an^{-1}) is very rational and cannot be fixed more precisely without a denser network of observation points.
Source: 7

#1768

Severne, B.C. "Nickel accumulation by Hybanthus floribundus." Nature (London), 248(5451):807-808 (April 26, 1974).

Studies of nickel accumulation by Hubanthus floribundus, an Australian shrub species which accumulates nickel and cobalt with modal levels of 5000 ppm and 100 ppm, respectively, in leaf tissue are reviewed, and a possible mechanism for the accumulation of nickel by this plant is proposed. Pearson product moment coefficient data are presented and indicate an inverse nickel-calcium relationship, suggesting a substitution mechanism which is supported by recent findings of nickel in pectinates. Accumulation of nickel in epidermal tissue of Hybanthus floribundus has been clearly demonstrated, but there is no evidence for a disposal mechanism, thus raising the question whether nickel is required by the plant. A mechanism is proposed whereby epidermal accumulation of nickel, where concentrations probably approach 5% or more (fresh weight), reduces cuticular transpiration and that nickel accumulation by the plant is a xeromorphic adaptation.
Source: 1

#1249

Shabad, L. M. "Studies in the U.S.S.R. on the distribution, circulation and fate of carcinogenic hydrocarbons in the human environment and the role of their deposition in tissues in carcinogenesis: a review." (Presented in Part at the 9th Int. Cancer Congr., Tokyo, Japan, October, 1966.) Cancer Res. 27(6):1132-1137 (June 1967).

By the use of quantitative spectrofluorescent assay of such carcinogenic hydrocarbons as benzo(a)pyrene (BP), it is possible to follow the carcinogenic hydrocarbons at different stages of their distribution and circulation in animal organisms and in human environment. The carcinogens circulate from one product to another, and from industrial and transport exhausts into the air. The exhausts from factories, heating systems, and combustion engines fall on soil, appear in water, accumulate or disappear, pass from nutrient

medium into microorganisms, and contaminate fodder and even human food. The action of some soil bacteria in transforming and destroying BP not only throws light on the fate of this material in the soil, but indicates the possibility of biological purification of the human environment from carcinogenic hydrocarbons. Modern accurate methods of hydrocarbon determination (for BP the limit is 0.000001 mg/ml) show new ways to cancer prevention.
Source: 1

#1250
Shabad, L.M., A.P. Alnitskiy, Yu.L. Kogan, G.A. Smirnov, and N.P. Shcherbak. "O kantserogennykh uglevodorodakh v pochvakh Sovetskogo Soyuza." (On the presence of carconogenic hydrocarbons in soils of the USSR). Kazan. Med. Zh., 5:6-11 (1971).

Polycyclic aromatic hydrocarbons, and especially benzo (a) pyrene, levels were determined in soil samples from different parts of the USSR. Urban air, which accumulates combustion and exhaust gases; industrial emissions; motor vehicles, including aircraft; and certain preparations used for soil erosion control were sources of C20H12 in the environment. Benzo (a) pyrene was detected in all soil and plant material samples investigated. The C20H12 levels were substantially higher in soil samples from urban and industrial areas as well as from highway belts than in such from rural areas. The C20H12 levels in soil samples from Moscow ranged from 70 to 346.5 micrograms/kg, and they were lowest in soil samples from Estonia with a minimum of 0.67 micrograms/kg. At a depth of 2.5 m., the C20H12 content of the soil was 0.12 micrograms/kg. No relationship between the C20H12 concentration and soil depth, and between the C20H12 concentrations in soil and corresponding plant material was established. The background concentration in natural environments usually ranged from 1 to 2 micrograms/kg. The presence of C20H12 in all soil and plant material samples may be due either to the natural background level due to the assumed existence of endogenous sources, or to the effect of aircraft emissions.
Source: 1

#1769
Shabad, L.M. and Y.L. Cohan. "The contents of benzo(a)pyrene in some crops." Arch. Geschwulstforsch., 40(3):237-243 (1972).

Experiments concerning the fate of benzo(a)pyrene in the soil are described along with findings from the chemical analysis of various crops grown in contaminated soil. The main source of benzo(a)pyrene contamination of the soil is its sedimentation from air, though experiments with the soil conditioner nerosin, a shale oil derivative, indicate that this compound is also responsible for introduction of the carcinogenic pyrene into the soil. The redistribution of the pyrene across soil layers is demonstrated along with its migration into plants. The main factor of benzo(a)pyrene destruction is the activity of soil bacteria. Evaluation of the pyrene content of various crops indicates that soil levels and particular features of individual plants determine the amount of crop contamination.
Source: 1

#1232

Shabad, L. M., Y. L. Cohan, A. P. Ilnitsky, A. Y. Khesina, N. P. Shcherbak, and G. A. Smirnov. "The carcinogenic hydrocarbon benzo(a)pyrene in the soil." J. Nat. Cancer Inst., 47(6):1179-1191 (Dec. 1971).

The content, distribution, and fate of benzo(a)pyrene in the soil of various USSR regions were investigated. A high content of the carcinogenic hydrocarbon was measured in the soil of an oil refinery; benzene extracts from this soil caused skin cancer in treated mice. The concentrations of benzo(a)pyrene were greater in the old areas of the large cities than in the newer areas and in urban sections as compared with rural sections. The background level was 1-3 micrograms/kg and did not exceed 10 micrograms/kg. The main source of soil contamination was its sedimentation from the air, particularly from aircraft exhausts. Content decreased with distance from source, but was spread within 3-5 km from the source. The redistribution of benzo(a)pyrene across soil layers and its migration into plants were studied. Seasonal variations of soil content are considered. The content eventually decreases and, at the doses applied, attains background values within a year. The main factor of benzo(a)pyrene destruction is the activity of soil bacteria.
Source: 1

#674

Shacklette, H. T., and J. J. Connor. "Airborne chemical elements in Spanish moss. Statistical studies in the field geochemistry." Geol Survey. Prof. Paper, 574E:1-50 (1973).

The epiphyte Spanish moss (Tillandsia usneoides L.) collected from its geographic range in the southern United States, was analyzed for 38 chemical elements in 123 samples. Sample analyses for rural, residential, highway, and industrial locations reflected significant differences in concentrations of metals. Samples from industrial and highway locations were characterized as containing greater-than-average amounts of arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and vanadium; high levels of lead found in some samples from highway locations were especially noteworthy. Many samples from sites near the seashore contained greater-than-average amounts of sodium that is thought to have been derived from ocean spray. Samples from rural locations commonly contained low concentrations of the metals usually associated with industrial or urban activity, but many contained large amounts of the elements that ordinarily constitute soil dust. Four of six samples containing detectable amounts of tin were collected within 50 mi of the only tin smelter in the United States, suggesting that elemental analyses of Spanish moss samples can provide an economical and rapid method of estimating the kind and relative degree of local atmospheric metal pollution.

Source: 1

#80
Shain, L., and W. E. Hillis. "Ethylene production in Pinus radiata in response to Sirex-Amylostereum attack." Phytopathology, 62:1407-1409 (1972).

Ethylene production was demonstrated in the sapwood of Pinus radiata which was mechanically injured or attacked by the wood wasp Sirex noctilio. Ethylene produced by the symbiotic fungus Amylostereum areolatum, which is inoculated into the tree at the time of oviposition, was negligible. Sirex lesions 1 to 4 weeks old in dominant trees produced significantly more ethylene than mechanically induced lesions or controls (42.3, 13.3, and 2.5 x 10^{-9} liter C_2H_4/g dry wood per hr, respectively). Similar figures for a suppressed tree were 4.6, 9.0, and 2.2 x 10^{-9} liter C_2H_4/g dry wood per hr. Trees which produced large quantities of ethylene in response to attack produced greater quantities of inhibitory phenols at a faster rate. The amount of ethylene produced may be a convenient and rapid means of distinguishing a susceptible from a resistant response. If heritable, the ability to produce large quantities of ethylene in response to attack may be a valuable parameter in breeding for disease resistance.
Source: 7

#1770
Shannon, J.G. and C.L. Muichi. "Ozone damage to wheat varieties at anthesis." Crop Sci., 14:335-337 (March-April 1974).

Two wheat cultivars, Arthur 71 and Blueboy, were exposed to 0.2 ppm ozone at anthesis for 4/hr/day for a week in a growth chamber. Yields were reduced by about 30 and 23% for Arthur 71 and Blueboy, respectively. However, the reduction for Blueboy was not statistically significant. Reductions in seed per plant and seed per head were not significantly different in the O3 treatment compared to the controls. Cultivars did not always respond in the same way to O3 for the characteristics studied. Ozone only slightly reduced the kernel weight in Blueboy compared to a significant, 17.4% reduction for Arthur 71: however, seed set was significantly reduced by 22.1% in Blueboy compared to 8.3% for Arthur 71. Since the O3 levels used in this experiment are often attained in fields near urban areas, the responses to O3 for wheat yield and yield components for the varieties studied should be comparable to actual field conditions.
Source: 1

#675
Sharma, G.K. and Joe Butler. "Leaf cuticular variations in Trifolium repens L. as indicators environmental pollution." Environ. Pollut., 5(4):287-293 (Dec 1973).

Two populations of white clover (Trifolium repens L.) were studied from selected rural and urban areas of Tennessee, to determine the relationship between variation in flower production, leaf cuticular features, and the environmental pollution in the area. In the rural, Reelfoot Lake location, sulfur dioxide and ozone pollution was mainly due to vehicular traffic. In the urban, Nashville area, pollutants were mainly sulfur dioxide, ozone, particulate matter, carbon monoxide, and other oxidants from vehicular traffic, heating plants, textile plants, glass manufacturing plants, fer-

tilizer plants, and a jet airport. In the rural area, stomatal frequency was 153.4 + or 14.1 (upper surface) and 44.3 + or 9.6 (lower surface), stomatal size range was 10-15 (upper) and 17-25 (lower), trichome density/sq cm was 25 (unicellular trichome on the lower surface) and 60 (multicellular trichome), trichome mean length was 82, subsidiary cell complex (cells) was 3-4, and average number of flowers/inflorescence was 69. The respective values for the urban area were 96.8 + or 10.3 and 37.2 + or -7.8, 7-17 and 15-25, 60 and 123, 95, 3-4, and 47. Thus, stomatal frequency values were low in populations from areas of high pollution. Trichome frequency and length increased in polluted areas, and trichome type was also affected. Floral productivity decreased in polluted areas. Stomatal size range and the number of subsidiary cells remained the same in both populations.
Source: 1

#1771
Shaulis, N.J., W.J. Kender, Charlotte Pratt, and W.A. Sinclair. "Evidence for injury by ozone in New York vineyards." HortScience, 7(6):570-572 (Dec 1972).

The effect of ozone on grapevines was studied and the data were correlated with field observations of injuries in New York vineyards. Widespread stippling and premature senescence of leaves of grapevines were observed in grapes grown near the Great Lakes. Identical symptoms were determined on grapevines exposed to 30 or 60 pphm ozone for 6 hr. The stippling, therefore, was a manifestation of 03 injury.
Source: 1

#676
Shaw, C. F., and F. E. Free. "Agronomic and soil conditions in the Selby smoke zone." Bull. Bureau Mines, 98:451-473, 503-520 (1915).

Maximum amounts of lead and arsenic found in soil samples from the Selby smoke zone were far too small to have any injurious effect on plants grown in the soils. Indeed, much larger amounts than those actually found would not affect the agriculture of the region. The poor agricultural conditions prevailing are amply accounted for by the naturally unfavorable soil and the extremely poor agricultural practices of the region.
Source: 1

#1772
Shaw, W.C., W.W. Hech, and H.E. Heggestad. "Role of agriculture in air pollution and control." Options Mediterr., 9:63-69 (Oct 1971).

General problems of air pollution afflicted damages to agriculture are described. The most important toxic air pollutants that originate primarily from nonagricultural sources and that affect agriculture include ozone, sulfur dioxide, peroxyacyl nitrates and other oxidants,

ethylene and other hydrocarbons, fluoride, chlorine, hydrogen chloride, nitrogen oxides, heavy metals, particulates, acid aerosols, ammonia, aldehydes, hydrogen sulfide, carbon monoxide, pesticide and other chemical wastes, and radioactive chemicals. Annual damage to agricultural crops and livestock is estimated at more than 0.5 billion dollars, and it is increasing each year. Current agricultural research is concerned with the development of chemical and bioassay techniques to detect the kinds, and measure the quantities of chemical pollutants in the air. Effects of pollutants on plants and animals are being determined. Chemical air pollutants that are being investigated include ozone, sulfur compounds, ethylene, peroxyacyl nitrates, fluorides, nitrogen oxides, chlorine, and automobile exhaust mixtures. Sites of action, mechanisms of action, and the fate of pollutants in plants, animals, and the environment are discussed. Current emphasis is also on research to determine crop yield and quality reductions under field conditions, to understand the influence of climatic, edaphic, and genetic factors as they relate to plant and animal susceptibility, and to develop biological indicators of pollutants. The effect of airborne herbicides, defoliants, desiccants, growth modifiers, nematicides, fungicides, and insecticides on plant growth are also being studied.
Source: 1

#359
Shcherbakov, A.P., and I.F. Cherednichenko. "Reaction of Trees and Shrubbery to Air Pollution in the Forest-Park Belt of Moscow and Measures for Extending the Lifespan of Plants." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Volume III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union. M. Y. Nuttonson (ed.) Silver Spring, Md., American Institute of Crop Ecology (1970) p. 13-22. (Also: Okhrana Priorody na Urale, 4:151-162 (1964).

In viewing the effect of air pollutants on vegetation, two aspects can be brought out; the protective role of green plantings as a shield blocking the penetration of noxious air downwind into the depth of the stand; and the negative physiological effect of mechanical and chemical air pollutants on vegetation. As a result of absorption of sulfur dioxide through the stomata, assimilation is disturbed, photosynthesis lowered, chloroplast iron inactivated, respiration frequently increased, vitamin B destroyed, an unfavorable protein and carbohydrate balance sets in, and the accumulation of silicic acid and strontium in the leaves increases. This is followed by the appearance of external symptoms of disturbed metabolism, injury to leaf tissue, leaf necrosis, all of which affect the growth of the leaf and the increment of the tree's height and diameter. The needles and the growth buds of spruce and pines growing in the smoke-polluted areas of the Moscow forest-park belt are greatly affected by air pollution. Indirect action of noxious gases in the air appears also through the soil, and systematic application of mineral fertilizer is recommended for planting subject to pollution by acid gases and smoke. Biometric data of pine and spruce needle growth in smoke polluted and smoke-free areas of the Moscow forest-park belt are presented tabularly.
Source: 1

#957
Shepherd, J.G. "Measurements of the direct deposition of sulfur dioxide onto grass and water by the profile method." Atmos. Environ., 8(1):69-74 (1974).

Measurements have been made of the rate of direct deposition of sulphur dioxide onto grass and water by the profile method. Over grass the deposition velocity is limited by a surface resistance which varies between 80 and 300 s m^{-1} and is comparable with stomatal resistance. Over water the deposition velocity is roughly proportional to wind speed, as would be expected if it were limited only by atmospheric resistance. It is however somewhat smaller than theoretical estimates for this situation, being about 1/1000 of the wind speed at a height of a few metres.
Source: 5, 6

#1112
Sherman, J.J. Open Land For Urban America, John Hopkins Press, Baltimore, 32 pp. (1972).

Definitions are given of open space land uses, classed into reserved, semi-reserved, restricted, and unreserved (susceptible to encroachment or development). Air space must be considered in future development, and the importance of preservation of space is discussed. Values of green space, ecological, physical and biochemical, are developed by the author. Dangers of increases in CO2, CO and SO2 ambient concentrations are stressed, and discussion of the carbon, nitrogen, and hydrological cycles are included.
Source: 8

#677
Shibukawa, S., Z. Kawase, M. Arai, and Y. Yoshida. "Shihyo shokubutsu ni yoru taiki osen chosa (daiippo)." Survey of air pollution indicated by plants (I)). Presented at the Japan Society of Air Pollution, Annual Meeting, 14th, Fukushima, Japan. Paper 268. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution) 8(3):542 (October 1973).

The state of photochemical smog was investigated in southern Saitama prefecture by plant indicators. Two types of morning glory, two species of coxcomb, scallions, and leaves of zelkova, gingko, plane, Himalayan cedar, and spindle tree were studied at 41 locations. Generally, damages were prevalent in southwest of the prefecture, which agreed with the smog warnings geographically; however, high oxidant counts did not necessarily produce damages, or agree with the degree of damages. The oxidant level of May 13 ranged between 0.08 and 0.18 ppm at various locations, and light to heavy chlorosis appeared on the Heavenly Blue species of morning glory, and heavy damages occurred on scallions. The spots of the damage and the direction of the wind were reversed in the case of scallions.
Source: 1

#236
Shibukawa, S., and Y. Ota. "Nosakubutsu no ozon shogai in taisuru kagaku yakuzai no koka ni tsuite." (Effect of chemical (benzimidazole, thiophanate methyl and potassium) in reducing ozone injury to vegetable crops). Text in Japanese. (Presented at the Japan. Society of Air Pollution, Annual Meeting, 14th, Fukushima, Japan, Paper 272, Nov. 6-8, 1973.) Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):546 (Oct. 1973).

Following the previous report on the effect of methyl thiophanate for reducing the damages of photochemical smog on agricultural produce, effective concentrations and time factors were studied, and the results were compared with that of benzimidazole. Spinach and radish were grown in pots, and 21, 11, 6, and 3 days prior to ozone exposure tests, 6.25-100 micrograms of benzimidazole and 77.5-310 micrograms of methyl thiophanate solutions were injected into the various pot soils. Exposures to 0.25 ppm O_3 was given for four hours to spinach and for 2.5 hours to radish. In all cases, benzimidazole showed a remarkable effect on reducing the damages of O_3, especially when injected 5-11 days prior to the exposure. Methyl thiophanate was very effective for radish but had no effect on spinach. Whether this was due to an insufficient amount of chemical or due to its selectivity is not clear at this stage of experiments.
Source: 1

#1981
Shibutani, S. and Y. Yasunobu. "Taiki osen busshitsu ga engei sakumotsu to ni oyobosu eikyo ni kansuru shiken (1) engei sakumotsu to no chiiki betsu higai jittai chosa, b. kaju (nashi) no shokusai shiken." (Experiments on the effects of air pollutant on horticultural crops: Part I. Investigation of local damage of horticultural crops. Sec. B. Effects of air pollutants on pear). Kanagawaken Nogyo Sogo Kenkyujo Gyomu Nenpo (Ann. Rep. Kanagawa Prefect. Agr, Integr. Inst.), 1973:74 (June 1973).

In the orchards at Kawasaki City, Yamato City, Isehara City, and Odawara City, the growth state, contents of the leaves, and yield of fruits of matured pear trees were investigated, as well as the degree of air pollution including sulfur oxides, nitrogen oxides, chloride ion, and dust fall. It seemed that air pollution (sulfur oxides of 0.80-0.36 mg/day/100 sq cm, nitrogen oxides of 0.01-0.06 mg/day/100 sq cm, chloride ion of 0.05-0.07 mg/day/100 sq cm, and dust fall of 7-25 tons/mo/sq km), was greater in Kawasaki and Yamato cities than in Isehara and Odawara cities. The effects of air pollution were evidenced only by an increased rate of leaf fall.
Source: 1

#865
Shinohara, Toshikiyo, Yoshitada Yamamoto, Hiroshi Kitano, and Michio Fukuda. "Effects of temperature on ozone injury to tobacco." Nippon Sakumotsu Gakkai Kiji (Proc. Crop Sci. Soc. Japan), 42(4):418-421 (Dec 1973).

The effects of temperature on ozone injury to three varieties of tobacco were studied in exposure chambers at 03 levels between 20-35 pphm and for exposure periods of 1.5-2.0 hrs. Plants grown at 23C were more sensitive to 03 than those grown at 13 C, with night temperatures producing

greater effects on the 03 sensitivity than daytime temperatures. Temperatures during fumigation were negatively corralated to the severity of 03 injury for temperatures between 13 and 32 C. The occurence and development of symptoms, as measured by the ratio of freshly-flecked leaves to total number of injured leaves, was accelerated by high temperatures after fumigation; although the amount of flecks and the number of leaves flecked were greater for plants subjected to lower temperatures subsequent to fumigation. No increase in leaf flecking occurred when 48 hrs or more elapsed following fumigation.
Source: 1

#866
Shinohara, Toshikiyo, Yoshitada Yamamoto, Hiroshi Kitano, and Michio Fukuda. "The relation between ozone treatment and the injury in tobacco." Nippon Sakumotsu Gakkai Kiji (Proc. Crop Sci. Soc. Japan), 42(4):412-417 (Dec 1973).

The effects of light and ozone exposure on three varieties of tobacco were investigated in fumigation chambers for exposure periods of 1-4 hr and 03 concentrations between 10 and 40 pphm. Light showed no effect on the plants response to 03 exposure. Visible damage in the form of leaf flecks was observed at 30 pphm for one variety and 20 pphm 03 for another variety of tobacco. Doses in shorter exposures were more injurious than equal or higher doses given over longer periods, indicating that 03 damage was not related to a simple dose-response concept. Detached leaves were suitable for 03 damage studies when fumigation was conducted for shorter periods such as 1-2 hrs.
Source: 1

#1776
Shinozaki, Mitsuo. "Kawasaki shinai no jumoku yomen fuchaku busshitsu oyobi yochu no ju kinzoku nado ni tsuite." (An investigation of heavy metals on and in the tree leaves in Kawasaki). Proc. Symp. Japan Soc. Air Pollut., 13th, p. 224. (Nov. 7-9, 1972).

Samplings of the tree leaves from three parks in Kawasaki were examined each month between May and December 1971 to see the effects of sulfur dioxide and settling particles. The metal content in the dusts on the surfaces of leaves and the metal and sulfur content in the leaves were measured. Metals were measured by the atomic absorption analysis method, and the sulfur content was measured by the sulfur atomatic analyzer. The average amounts of settling particles in leaves in the industrial area were 400-1600 mg/1 sq m, in the commercial area 200-1400 mg/1 sq m, and in the residential suburbs 100-800 mg/1 sq m. The metal content decreased with the increase of the total amount of dusts. Iron and manganese ratios were clearly higher in the industrial areas. The ratio of iron, zinc, copper, nickel, lead, and manganese in the settling particles were 1.9-25.8% in the industrial areas, 1.8-12.5% in the commerical areas, and 0.2-10.7% in the suburbs. The metal content in the leaves were 1277 ppm in the industrial area, 534 in the commer-

cial area, and 390 in the suburbs. The Zn counts were 90, 82, and 60 ppm, respectively; Cu counts were all 9 ppm; Ni measurements were 7, 6, and 4 ppm; Pb measurements were 11, 10, and 7 ppm; and Mn measurements were 178, 51, and 74 ppm. In the industrial area, there was a tendency for water-soluble sulfur to increase in the leaves of ginko and pasania with the time. An index for pollution may be obtained by examining the relationship between water-soluble sulfur and the total sulfur.
Source: 1

#1777
Shinozaki, Mitsuo. "Kanagawaken ni okeru taiki osen ni yoru shokubutsu higai no genjo." (The status quo of plant damage by air pollution in Kanagawa Prefecture). Shokubutsu Boeki (Plant Prot.), 27(6):245-248 (1973).

Sulfur oxides and photochemical oxidants cause plant damage in Kanagawa Prefecture. Ginkgo trees are conspicuous affected by SOx leaf surface area increases with increasing distance away from the industrial area; sulfur, iron, zinc, lead, copper, nickel, and cadium content of the leaf increases with decreasing distance between the ginko trees and the industrial area. Physiological effects occur when the content of S, Fe, and Pb become more than 4000, 1000, and 10 ppm, respectively. Sulfur content and effects differ with different plant species. The sulfur content of an unpolluted area s trees can be set at 100 as an index, and the sum of the indices of ginkgo, zelkova and pine trees then represents the air pollution of that area. Photochemical oxidants occurred 11 times in 1971 and 31 times in 1972 throughout the Prefecture. Japanese leek, spinach, turnip, salting green, and soy plants show oxidant damage. Chard damage can act as a pollution index. Chard indicator plants were planted at 60 places; damage was assessed on the 20th of each month and after oxidant concentrations exceeded 0.15 ppm. Of 3755 samples, 157 samples had damage, including 69 of chard, 20 of spinach, 12 of turnip, and 11 of Japaneese radish. Of 49 species, damage was observed on 14 species. Damage was greater in the inland area. Chard damage includes chlorosis and necrosis on both sides of the leaf, a different result than that obtained during a labratory test with 0.15 ppm of ozone for 6-10 min. Spinach damage in the Prefecture resembled damage produced during a labratory exposure to 0.4 ppm of ozone.
Source: 1

#1774
Shinozaki, M. and M. Maeno. "Yuga gasu ni yoru shokubutsu higai no kaiseki (1) yuga gasu ni yoru shokubutsu higai no kaiseki ni kansuru shiken: a. horenso no ozon shogai keigen ni kansuru piperoniru butokisaido no koka." (Analyses of plant injuries due to harmful gases: Part I. Experiments on the analyses of plant injuries due to harmful gases: Sec. A., Effect of reducing ozone injuries on spinach of Piperonyl Butoxide). Kanagawa-ken Nohyo Sogo Kenkyujo Gyomu Nenpo (Ann. Rep. Kanagawa Prefect. Agr. Integr. Inst.), 1973:71 (June 1974).

In order to discuss the effects of piperonyl butoxide on reducing ozone plant injuries, a series of multifactor experiments were carried out on spinach. The tested factors consisted of ozone exposure (0.2 ppm, for 3 hr), nitrogen fertilizer, potassium fertilizer and scattering of piperonyl butoxide on the leaf surface, with corresponding levels of exposure of one and two times, one and two g, two and three g. and scattering and non-scattering. The results were: the number of leaves damaged on more than 30% of the surface area by a one-time exposure to ozone was 11.2 in an unscattered plot compared to 0.2 with piperonyl butoxide treatment in the scattered plot; that by two-time exposure to ozone was 15.4 in an unscattered plot, compared to a 1.7 in a scattered plot; the effect of piperonyl butoxide persisted after 5 days of ozone exposure; potassium fertilizer when used in greater amount reduced the ozone damage a little; and there was a mutual action between potassium fertilizer and piperonyl butoxide scattering, potassium being a little effective when unscattered.
Source: 1

#1775

Shinozaki, M., M. Maeno, Y. Mizusawa, N. Hiratsuka, and K. Dohi. "Taiki osen busshitsu ga engei sakumotsu to ni oyobosu eikyo ni kansuru shiken (2) osen busshitsu no engei sakumotsu to ni oyobosu eikyo shiken, a. kuki joka ga yasai to no seiiku no oyobosu eikyo shiken." (Experiments on the effects of air pollutants to horticultural crops: Part II. Experiments. Sec. A. Experiments on the effects of cleaned air to the growth of vegetables). Kanagawa-ken Nogyo Sogo Kenkyujo Gyomu Nenpo (Ann. Rep. Kanagawa Prefect. Agr. Integr. Inst.), 1973:74-75 (June 1974).

Welsh onion, spinach, morning glory, a salting green, Chinese cabbage, peanut, taro, turnip, and mulberry trees were grown in a polyvinyl chloride greenhouse into which fresh cleaned air (cleaned in a filter containing maganese catalyst and active charcoal) was introduced. The temperature difference between inside and outside of the house was maintained at about 5 C. The same species of plants were also grown in the same sized greenhouse into which fresh outside air was introduced (through a filter without a catalyst). At the times when a high concentration of photochemical smog occurred in the area of the greenhouse, conspicuous damage appeared on spinach, Welsh onion, and morning glory in the untreated control greenhouse, but in the greenhouse supplied with cleaned air, almost no damage was observed. The capacity of the catalyst was that the oxidant concentration was reduced to from a third to a fourth for consecutive 6 months. The cost of installing a set of such catalyst-bearing filters was about $1333.
Source: 1

#956

Shir, C.C. and L.J. Sheih. "A generalized urban air pollution model and its application to the study of SO_2 distributions in the St. Louis metropolitan area." IBM Research, RJ 12 27, Yorktown Heights, New York, 75 pp. (1973).

A generalized urban air pollution model, based on numerical integration of the concentration equation, is developed for the study of air pollutant distributions over an urban area. The model computes the temporal and three dimensional spatial concentration distributions resulting from specified multiple point and area sources by using currently available meteorological and source inventory data. A new method based on experiments and turbulence transport model is used to estimate the turbulent diffusivity and atmospheric stability. Special treatments of the finite difference scheme to accomodate the large variations of concentrations are discussed. An effort has been made to avoid any subjective analysis scheme for the preparation of the input data. The model was used to study SO_2 distributions in the St. Louis metropolitan area during 25 consecutive days in February 1965. The computed results were evaluated with respect to observed data by using various statistical methods. The computed results agree favorably with experimental measurements for both long-term and short-term average concentrations. Computations also indicate the model's capabilities and flexibilities for dealing with the rapid variations of atmospheric conditions. The advantages and limitations of the model are also discussed.
Source: 5

#510

Shriner, D.S. and N.L. Lacasse. "Rapid determination of chloride content of vegetation for assessment of air pollution injury from hydrogen chloride." Phytopathology, 62(4):427-429 (April 1972).

Twenty-eight-day-old tomato plants (Lycopersicon esculentum "Bonny Best") and rooted cuttings of chrysanthemums (Chrysanthemum morifolium "Neptune") were exposed to hydrogen chloride (HCl) gas at concentrations ranging from 2 to 18 ppm for time periods ranging from 1 to 3 hr. Relative humidity of the exposure environment was maintained between 65 and 75%, and a light irradiance of 3.9×10^4 ergs/cm^2 per sec was provided. Water extracts of macerated plant tissues were titrated with a chloridometer. Large increases in chloride content were recorded for all aboveground parts of fumigated plants as compared to control plants and plant parts. Greatest increases in tomato occurred in those leaves which were not yet fully expanded. Greatest increases in chrysanthemum occurred in immature upper leaves. The pattern of the uptake of chlorides in tomato and chrysanthemum is similar to that reported for fluorides. The procedure has potential usefulness as a diagnostic tool in assessment of air pollution injury from HCl gas.
Source: 2

#1778
Showman, Ray E. "Residual effects of sulfur dioxide on the net photosynthetic and respiratory rates of lichen thalli and cultured lichen symbionts." Bryologist, 75(3):335-341 (Fall 1972).

The physiological effects of sulfur dioxide exposure on several common lichens and their isolated symbionts were investigated. Sulfur dioxide exposure decreased net photosynthesis and respiration in the cultured lichen; physiological responses at the same SO2 exposure were different for whole thalli, and the mycobionts of the three lichen species were also differentially sensitive. Chlorophyll damage was not noted in the exposed phycobionts.
Source: 1

#235
Shupe, J.L. "Diagnosis of fluorosis in cattle." Publication of the 4th International Meeting, World Society for Buiatrik, Zurich, Switzerland, 17 p., Aug. 4-9, 1966.

Structural and physiological processes of animals that ingest fluorine are governed by a number of factors: (1) level or amount of fluoride ingested, (2) duration of ingestion time, (3) type and solubility of fluoride ingested, (4) age of animal at time of ingestion, (5) level of nutrition, (6) stress factors, and (8) individual biological response. Prevention and control of fluorosis in livestock can be achieved but only when the complexity of the disease is realized and the pathogenesis, symptomatology, and lesions are properly correlated, interpreted, and evaluated. By computations, the data show that by taking into account the amount of fluorine in the rib and the tooth classification, 95 per cent ($r^2=0.950$) of the variability can be accounted for. In other words, the tooth classification and the amount of fluorine in the ribs can be used to predict the extent of fluorosis with a high degree of accuracy. Other examples of multiple correlation formulas are shown. A comprehensive guide was developed to facilitate diagnosing and evaluating fluorosis. The data in the Table are based on short and long term controlled experiments, clinical examinations of more than 70,000 animals in endemic fluorosis areas and 510 detailed necropsy findings of animals of different ages evidencing various degrees of fluorosis.
Source: 1

#1779
Siegel, S.M. "Protection of plants against airborne oxidants: Cucumber seedlings at extreme ozone levels." Plant Physiol., 37:261-266 (1962).

A variety of oxidation-inhibiting or reducing substances (indole, IAA, tryptophane, mescaline, hydrazine, isonicotinyl hydrazine, ascorbic acid, octadeccne-1 and DPNH) protect cucumber seedlings against acute ozone exposures (2.5-5.8 mg/liter for 30 min); the observed protective activities include both increased survival of seedling populations and reduced inhibition of hypocotyl section elongation. Compounds with little or no antioxidant activity failed to protect againt ozone damage; $CoCl_2$ intensifield ozone damage, its other protective abilities notwithstanding. A comparison of root immersion, whole seedling immersion, and aerial application showed that protection of the aerial portion of the plant can be effected by compounds supplied entirely through the roots.
Source: 1

#237

Siegel, S. M. "Lead: aspects of its ecology and environmental toxicity (semi-annual report)." Hawaii Univ., Botany Dept., National Aeronautics and Space Administration Grant NGL 12-001-042, NASA-CR-138385, Hawaii Univ., Botanical Science Paper 32, 63 p. (May 1973). NTIS: N74-22959.

The abundance of lead in soils and vegetation in Honolulu, Hawaii was studied. Parkland soils and vegetation were heavily contaminated with lead and zinc from automobiles. Copper in the same soils and vegetation may also have come from automobiles. Some of the lead appears to have entered terrestrial food chains. The lead values for roadside grasses (20-1050 micrograms/g) and soils (30-4300 micrograms/g) are among the highest reported for exhaust contamination. By comparison, grasses from one of the busiest intersections on the sparsely populated island of Kauai contained 52.5 micrograms/g plant. The background level for lead in Hawaiian vegetation may be less than 5 micrograms/g. The high values on Oahu reflect unusually high traffic densities in the vicinity of the sampling sites, the prevailing winds, and the high mean annual temperature. Lead and other metals were also measured in the Ala Wai Canal. The extent of lead consumption for Oahu is described. The amount of lead oxide or lead nitrate absorbed by the fungus Aspergillus clavatus Desm was tested in the laboratory.
Source: 1

#265

Siegel, S. M. "Mercury: Aspects of its ecology and environmental toxicity (semi-annual report). Hawaii Univ., Botany Dept., National Aeronautics and Space Administration Grant NGL 12-001-042, NASA-CR-13838, Hawaii Univ., Botanical Science Paper 33, 59 p. (June 1973). NTIS: N74-22960.

Mercury in the environment is reviewed, including its abundance, toxicity, and sources. Minimata disease, organic mercury poisoning, biological alkylation, effects of mercury on enzymes, the mercury in fish scare, and mercury in the environment are reviewed. Results of a study of mercury contamination in Hawaii are also presented. Mercury was measured in air, plants, fish, beef kidney, rain, water, soil, sediment, and rock samples. The mercury concentrations in micrograms/cu m were 0.04 + or - 0.02 at the Manoa Campus, University of Hawaii, 0.14 + or - 0.10 at Ala Moana Blvd. at Piikoi Street, 40.5 and 0.73 at Halemaumau Caldera, and 23.3 + or - 5.4, 21.4 + or - 8.5, 2.2 + or - 1.0, and 33.5 + or 7.4 on various dates as Sulfur Banks. Mercury contents in microgram/l were 20-40 in the fumarole condensates at the Sulfur Banks, 0.17 + or - 0.05 in rainwater at seven sites on Hawaii, and 0.15 in rainwater at Lihue, Kauai. The evidence showed mercury principally enters the Hawaiian environment as a natural product of vulcanism.
Source: 1

#65
Siegel, S. M. "Lead: aspects of its ecology and environmental toxicity." University of Hawaii. Botanical Science Paper, No. 32. Informal technical report, neither to be cited nor credited as a publication.

Parkland soils and vegetation in Honolulu, Hawaii are heavily contaminated with lead and zinc originating from automobiles. Copper in the same soils and vegetation may also come from automobiles. Some of the lead appears to have entered terrestrial food chains. The lead values for grasses (20-1050 $\mu g\ g^{-1}$) and soils (30-4300 $\mu g\ g^{-1}$) are among the highest reported for exhaust contamination. By comparison, grasses from one of the busiest intersections on the sparsely populated island of Kauai contained 52.5 $\mu g\ g^{-1}$ plant. The background level for lead in Hawaiian vegetation may be at less than 5 $\mu g\ g^{-1}$. The high values on Oahu reflect unusually high traffic densities in the vicinity of the sampling sites, the prevailing winds and the high mean annual temperature.
Source: 8

#261
Siegel, S.M., B.Z. Siegel, A.M. Eshleman, and K. Bachmann. "Geothermal sources and distribution of mercury in Hawaii." Environ. Biol. Med., 2:81-89 (1973).

Measurements were taken of mercury in the air, water, rain, soils, rocks, and biological materials from the islands of Hawaii, Maui, and Oahu. Some high values were found, probably due to geothermal sources rather than industrial sources. Present Hg levels reflect the atmospheric dispersal of gaseous and particulate Hg discharged by volcanoes on Hawaii and on all the islands in the Hawaiian Archipelago. Bioconcentration of Hg by plants and fungi also caused high Hg values. Relatively large amounts of Hg in the air samples from Honolulu warrant further study to determine possible effects on human health. Air Hg levels were 40.7 + or - 1.3, 2.2 + or - 1.0, and 33.5 + or - 7.4 during three different days at a site near the sulfur banks. Near other volcanoes levels were 40.5, 0.73, and 3.53 + or - 7.1. Particulate Hg in atmospheric samples was 21.1 + or - 3.3 and 2.2 + or - 1.0 micrograms/cu m. The Hg deposition on surfaces of copper, silver, and gold was 377, 396, and 80 micrograms/sq m, respectively. Mercury levels in Honolulu at a beach front were 0.06-1.41 micrograms/cu m. The grass in the parkland adjoining the beach front contained up to 500 pb Hg. The sediments underlying shallow reef-enclosed waters of Honolulu yielded up to 200 ppb.
Source: 1

#1781
Sierpinski, Zbigniew. "Szkodniki wtorne sosny w drzewostanach znajdujacych sie w zasiegu dzialania emisji przemyslowych zawierajachcy zwiazki azotowe." (Secondary noxious insects of pine in stands growing in areas with industrial air pollution containing nitrogen compounds). Sylwan, 115(10):11-18 (Oct 1971).

The effects of emissions from a nitrogen plant on pine stands in the area with respect to secondary insect populations, their qualitiative composition, changes in population dynamics, and the economic significance of the

effects were examined. The experimental stands were within the range of the effects of aerosols of ammonium sulfate, gaseous ammonia, nitrogen oxides, dust, and sulfur dioxide. The short-term very high concentrations of the nitrogen compounds resulted in quick necrobiosis of the tree stands, so that around 130 hectares of stands were destroyed by industrial emissions in 1967-1971. Secondary noxious insects attacked about 35% of the dead and dying trees. The population density of these insects was greatest in the zone of low exposure to industrial pollution and was least in stands exposed by cutting and felling.
Source: 1

#1780
Sierpinski, Z. "Die Bedeutung der sekundaeren Kiefernschaedlinge in Gebieten chronischer Einwirkung industrieller Luftverunreinigungen." (The significance of secondary pine parasites in areas of chronic exposure to industrial pollution). Mitt. Forst. Bundesvers., 97:609-615 (1972).

Investigations and observations conducted in forested areas of Poland within range of industrial air pollutant exposure have shown than insects of the secondary parasite group are of great economical significance and can decide the mortality of the trees. Pine stands under the chronic effect of industrial emissions have their treetops weakened, and numerous hatching parasites are found under the thin bark of the top and branches. The parasite contributes to the thinning out of the stands and hence to the wind damage and more intensive penetration by industrial emissions into the lower forest layers and the soil. Two groups of secondary parasites have appeared that are clearly distinct from each other. The first group includes the blue pine beetle, the pine trunk beetle, and the blue spruce wood wasp and occurs most frequently in strongly thinned out stands at the edge of forests near industrial plants. The second group includes the large forest gardner, the room longicorn beetle, the pincer longicorn beetle, and the common timber bark beetle. The latter settle in denser stands no exposed to industrial emissions. Even a weak attack by parasites can cause mortality due to the very low resistance of the trees in areas chronically exposed to industrial flue gasses and smokes.
Source: 1

#678
Simonsson, Lennart. "Skador och obehag orsakade av industriell fororening av atmosfaren." (Damages and discomforts caused by industrial pollution of the atmosphere). IVA (Ingenioersvetenskapsakad) Tidstr., 26:141-163 (1955).

An extensive review is made of the literature of the effects on humans, livestock, and plant life of the various types of gaseous and particulate air pollutants, including sulfur oxides, hydrogen sulfide, fluorine compounds, chlorine, hydrogen chloride, nitrogen oxides, ammonia, organic compounds, and dust. Of these, the most extensive treatment is given to the effects of sulfur compounds and halides. The effects of sulfur dioxide on plants is discussed in great detail. The effect of low concentrations of sulfur compounds in the atmosphere on plant life are being studied in Sweden at the agricultural school in Ultuna.
Source: 1

#1782
Sinclair, Michael Gervase. "The effects of ozone on two varieties of tobacco pollen and on the conidia of the fungus Monilinia fructicola." Delaware Univ., Dept. of Plant Pathology, Thesis (M.S.), 64 p. (June 1969).

Tobacco plants have been widely used as biological indicators of ozone. The variety Bel W-3 is extremely susceptible to ambient levels of O3 (1-15 pphm) whereas the variety Bel B is resistant at these concentrations. Experiments were performed to determine whether the pollen of these two varieties exhibited the same response. Similar tests were also conducted on the macroconidia of the fungus causing brown rot of stone fruits. The O3 analysis was done with 1% potassium iodide dissolved in a neutral buffer consisting of 0.1 M disodium hydrogen phosphate and 0.1 M potassium dihydrogen phosphate. The O3 liberated iodine from the iodide solution and the absorbance was determined in a spectrophotometer at 352 millimicron. The pollen grains were cultured at a temperature of 30 C in a medium of 21% sucrose and 91 ppm boron. The macroconidia of Monilinia fructicola were incubated at 25 C in a medium of 0.01 M succinic acid and 0.01 citric acid in a 0.1 M phosphate buffer. With the system as described, O3 at ambient levels appeared to have little effect on the macroconidia or on the pollen of Bel W-3 and Bel B. At higher concentrations, the O3 stimulated the percentage of germination and the growth of the macroconidia and the pollen grains of both varieties.
Source: 1

#867
Singer, Maximilian. "Uber den Einfluss der Laboratoriumsluft auf das Wachstum Kartoffelsprosse." (On the effect of a laboratory atmosphere on the growth of potato sprouts). Ber. Duet. Botan. Ges., 21:175-180 (1903).

The growth of potato sprouts under the influence of a laboratory atmosphere in which coal gas was present was investigated. When a potato shoot approximately 7 cm high and several smaller shoots which were grown in a greenhouse under a bell jar, were placed in a laboratory room the shoots twisted from a vertical to a horizontal direction. If potatoes were brought into the laboratory and covered with a layer of water, they continued to grow in a vertical direction. It was confirmed that the twisting of the shoots was not due to heliotropism, humidity, or hydrotropism; the reason for the twisting was the effect of the impure laboratory atmosphere which contained coal gas. A coal gas concentration of 0.1% induces twisting and thickening in the potato sprouts. If the concentration is reduced to 0.002%, no twisting of the main sprout is produced.
Source: 1

#1248
Singer, M. J., and L. Hanson. "Lead accumulation in soils near highways in the twin cities metropolitan area." Soil Sci. Soc. Am. Proc., 33(1):152-153 (1969).

The use of tetraethyl lead in vehicle fuel has resulted in a general increase in the lead content of both the atmosphere and the soil. Most of the lead from gasoline exhausts is deposited as the highly soluble chlorobromide. The soil adjacent to 12 highways in the Minneapolis-St. Paul metropolitan area had lead accumulations in the range of 128 to 700 ppm. The lead concentrations found were related to traffic volume and distance from the highway. Further studies are needed to determine if biological or environmental hazards are possible from the lead contained in these soils. (Author abstract modified).
Source: 1

#1928
Sitnikova, A.S. "Characteristics of photosynthesis and of some other processes in connection with smoke and gas resistance of trees and shrubs." In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Vol III. The Susceptibility of Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union, M.Y. Nuttonson (ed.), Silver Spring, Md., American Institute of Crop Ecology, p. 68-69 (1970).

Studies were conducted in the Karaganda region of the Kazakh SSP. to determine the effects of soil, climate, and air pollution on plant growth, photosynthesis, and the dynamics of chlorophyll and carbohydrate accumulation. The following plants were investigated over a three-year period: European white birch, pinnate elm, common lilac, Tartarian honeysuckle, box elder, balsam poplar, oleaster, Scotch pine, and Siberian pea shrub. In the proximity of an ore-concentrating mill and metallurgical plant, growth of box elder, oleaster, and Siberian pea shrub was accelerated. Gas and dust emissions from these sources intensified the growth of lateral shoots in the balsam poplar, oleaster, and pinnate elm and increased the chlorophyll content of the common lilac, oleaster, and pinnate elm. Appreciable gas and smoke pollution hampered photosynthesis in most plants, but enhanced in the oleaster and the pinnate elm. From point of view of oxidizability of cell sap, gas resistance of the plants studied decreases in the following order: pinnate elm, oleaster, balsam poplar, box elder, Tartarian honeysuckle, Siberian pea shrub, common lilac, European white birch, and Scotch pine.
Source: 1

#1783
Sivtsev, M.V. and S.A. Ponomareva. "Anatomicheskaya struktura ovodnennost list yev tomatov i aktvnost v nikh khlorofillazy pri khloridnom zasolenii." (Anatomical structure, water-storage capacity of tomato leaves, and chlorophyllase activity in them upon chloride salinization). Biol. nauki, 3: 84-87 (1973).

Tomato plants were exposed to chloride salinization in glass containers to investigate the influence of different sodium chloride concentrations on

the change in anatomical structure, water-storage capcity, and chlorophyllase activity. Salinization increased the leaf succulence factor and the water-storage capacity of the tissues, with the latter two effects being positively correlated with the hydrolytic activity of the chlorophyllase. The activity of chlorophyllase was greater relative to chlorophyll a than to chlorophyll b.
Source: 1

#1933
Skelly, J.M., L.D. Moore, and L.L. Stone. "Symptom expression of Eastern White Pine located near a source of oxides of nitrogen and sulfur dioxide." Plant Disease Reptr., 56(1):3-6 (Jan 1972).

The synergistic effects of sulfur dioxide and industrial emissions of nitrogen oxides (nitric oxide and nitrogen dioxide) on Eastern White Pine (Pinus strobus) and three other conifer species were investigated. Ambient levels of the pollutants were recorded at seven monitoring stations. The highest 1-hour concentration of NOx was greater than 0.585 ppm at a station 600 yards downwind from the source and the highest 2-hour SO2 concentration was 0.690 ppm at a station 400 yards downwind from the source. Eastern White Pine seedlings and larger trees were the most severely affected and exhibited acute symptoms, including tip burn, chlorotic mottle, and stunted growth.
Source: 1

#1934
Skowina, Tadeusz, Irena Szalonek, Maria Warteresiewicz, and Tadeusz Wachalewski. "Zastosowanie testu roslinnego do oceny stopnia zanieczyszczenia powietrza atmosferycznego dwutlenkien siarki." (Application of a plant test for the evaluation of air pollution by sulfur dioxide). Postepy nauk roln (Warsaw), 3(87):17-31 (1964).

A relationship between the amount of sulfur dioxide in the polluted air and sulfates determined in rye leaves was established. This relationship provides the possibility to characterize the degree of SO2 contamination in different areas. Accumulation of SO2 in rye leaves occurred throughout the vegetation cycle, but its final stage appeared to be the most appropriate for sample analysis. No relationship between sulfate amounts found in leaves and those determined in the respective grounds could be established. The sulfate levels determined in rye leaves depended on the amount of SO2 in the polluted air as affected by emission source, geographic location, meteorological conditions, and prevailing wind directions.
Source: 1

#1785
Skye, Eric. "Rekimmendationer rorande riktvarden for svaveldioxidhalt i utomhusluft." (Effects of sulfur dioxide on plants and animals). In: Recommendations relating to norms for sulfur dioxide content in open air. Swedish Government Air Pollution Board,(Stockholm), Communication 6601 (1965)-(?).

The first plant organisms damaged by sulfur dioxide are the lichens on tree trunks. Herbs, grasses, and woody plants often show typical damage at contrations as low as 30 ppm. Coniferous trees are attacked at the tips of the needles, damage then spreading toward the needle base. The parts attacked turn red or whitish in color. Grasses and liliaceous plants show brown spots at the tips of the leaves. Grass blades become limp and are streaked with brown. When severely attacked, trees, shrubs, and herbs show damage to the leaf surface between the veins. The site attacked turns yellow, brown or red and the tissues dry rapidly. In animals, the respiratory tract is usually affected. The reaction of insects such as bees and butterflies is not known.
Source: 1

#1784
Skye, Erik and Ingemar Hallberg. "Changes in the lichen flora following air pollution." Oikos, 20(2):547-552 (1969).

Lichen flora on tree trunks around a shale oil works were analyzed with regard to composition and distribution in 1951/1953 and in 1967/1969. Changes in lichen distribution were observed and attributed to increased levels of atmospheric sulfur dioxide that persisted until production at the shale oil works was terminated in 1966. Between 1953 and 1967, lichen species normally connected with acid barks increased markedly. Their appearance on trees that normally have only moderately acid bark indicates that the substrate is obviously being acidified within the investigation area. Bark originally of relatively high pH needs a longer time or more intensive exposure to acid chemicals to reach a pH level within the tolerance of lichens normally found on acid bark. Probably direct poisoning of the lichens also plays a part in these changes. By the summer of 1967, some signs of recovery were observed in certain lichen species, in particular, strong lobe growth in lichen thallus.
Source: 1

#285
Slinn, W. G. N. "Initial resuspension models." In: Pacific Northwest Laboratory Annual Report for 1972 to the USAEC Division of Biomedical and Environmental Research. Battelle Memorial Inst., Richland, Wash., Pacific Northwest Labs., p. 5-15 (April 1973) Vol. II: Physical Sciences. Part 1. Atmospheric Sciences.

The resuspension of aerosol particles from the earth's surface was studied theoretically. For friction velocity greater than or approximately equal to 20 cm/sec, horizontal wind fluctuations can dislodge most sub-millimeter particles from dry soil. This suggests that the soil particle size distribution is the controlling factor of the airborne particle size distribution in the near-surface layer. Above the surface layer, the convective diffusion equation is incapable of explaining experimental data. The resuspension of the material into the force convection layer depends almost entirely on the statistical properties of the turbulence. A statistical approach based on the probability distribution of vertical wind speeds is explored; the observed wind speed data does correctly describe the size distribution of large, resuspended particles. Directions are indicated for future theoretical and experimental studies.
Source: 1

#1247

Smika, D.E. "Dust in the air from soil." Proc. Explor. Nebr. Pollut. Probl., Lincoln, Nebraska, pp. D-1 - D-7 (1971).

Dust in the air of the Central Great Plains is examined with respect to historical perspective, measurement methods, problems, the influence of climatic factors of wind and rain, effects of land management, soil control to prevent airborne particulates, and dust hazards. Measurement devices included collectors for particles settling out of the air due to gravity, affected by wind current and actual velocity, and collectors for suspended particulates, including filtration, impingers, electrostatic and thermal precipitators, and centrifuges.
Source: 1

#868

Smith, C.W. "Lichens as an indicator of air pollution." Hawaii Univ., Honolulu. 6 p. (1968).

The population density of lichens in urban areas depends upon the relative humidity and temperature, the removal of the indigenous population among construction, and air pollutants. The results of a study conducted in three principle areas in Hawaii to determine the lichen population are presented. The effects of sulfur dioxide and automobile-associated pollutants are noted, along with rainfall and other significant factors. The effort of the 'city desert climate' results from an increase in asphalt-covered ground, causing more extreme temperatures and lower relative humidifiers than are normally found in natural areas. There is no apparent mechanism whereby lichens can excrete or detoxify substances which are not part of their normal atmosphere or substrate. The appearance of lichens on various types of trees in the areas investigated are tabulated.
Source: 1

#1786

Smith, Dixie R. "Pollution and range ecosystems." In: Man's Impact on Terrestrial and Oceanic Ecosystems, William Henry Matthews (comp.), MIT Press, Cambridge, Mass., 130-143 (Chapt. 8) (1971).

The range ecosystem contains a characteristic biotic community that functions together with the nonliving environment as a complex system. The effects of pollutants on ecosystems are complex, with the parameters most changed being diversity, structure, and the ratio of photosynthesis to respiration. Specific pollutants affecting the range include: carbon dioxide, of which the range may contribute large amounts while playing a limited role in its reduction; pesticides, which have probably not accumulated in the soils of the range ecosystem; heat, which can greatly affect the range although the latter is not a source of it; nitrogen-phosphorus-potassium fertilizers, which do not now nor probably ever will constitute a problem for radioactive compounds, which occur naturally, but some of which, resulting from atomic explosions, can be quite harmful to the range ecosystem; sediment, which is the greatest pollutant of surface waters; and particulate matter, which has several direct and indirect effects upon the range ecosystem.
Source: 1

#238

Smith, D. W., C. B. Fliermans, and T. D. Brock. "Technique for measuring $14CO_2$ uptake by soil microorganisms in situ." Appl. Microbiol., 23(3):595-600 (March 1972).

Uptake of (14) carbon dioxide in soils due to algae or sulfur-oxidizing bacteria was examined by incubation of soil samples with gaseous $(14)CO_2$ and subsequent chemical oxidation of biologically fixed radioactive isotope to $(14)CO_2$ for detection with a liquid scintillation counting system. The $(14)CO_2$ was added to the soil in the gas phase so that no alteration of the moisture of ionic strength of the soil occurred. Wet oxidation or radioactive organic matter was carried out in sealed ampoules, and the $(14)CO_2$ produced was transferred to a phenethylamine-liquid scintillation counting system with a simply constructed apparatus. The technique is inexpensive and efficient and does not require elaborate traps since nonradioactive CO_2, chloride, and water have no harmful effects. Experiments in coal mine regions and in geothermal habitats demonstrated the applicability of the method for in situ ecological studies in soils.
Source: 1

#83

Smith, K.A., J.M. Bremner and M.A. Tabatabai. "Sorption of gaseous atmospheric pollutants by soils." Soil Science, 116(4):313-319 (1973).

Gas chromatographic studies showed that soils have the capacity to sorb substantial amounts of sulfur dioxide, hydrogen sulfide, and methyl mercaptan and small amounts of carbon monoxide, ethylene, and acetylene. Sulfur dioxide was sorbed more rapidly than H2S or CH3SH, and all three sulfur gases were sorbed much more rapidly than CO, C2H4, or C2H2. When expressed as mg of gas sorbed/g of soil, the capacities of air-dry samples of the soils studied for sorption of sulfur gases ranged from 1.1 to 15.3 for SO2, from 15.4 to 65.2 for H2S, and from 2.4 to 32.1 for CH3SH. The corresponding capacities of moist (50 percent WHC) samples ranged from 9.3 to 66.8 for SO2, from 11.0 to 62.5 for H2S, and from 2.2 to 21.4 for CH3SH. The rates of sorption of these gases and the amounts of gas sorbed were not significantly correlated with soil pH, organic-matter content, or clay content. Experiments with steam-sterilized soils indicated that soil microorganisms are responsible for the sorption of CO, C2H4, and C2H2 by moist soils, but play little, if any, part in the sorption of SO2, H2S, and CH3SH. Evolution of CO was detected from moist (50 percent WHC) samples of several of the soils studied, and this evolution was promoted by steam sterilization of these soils. The work reported indicates that soil is an important natural sink for gaseous atmospheric pollutants and may prove valuable for purification of industrial emissions heavily polluted by sulfur gases.
Source: 7,1,6

#153

Smith, W. H. "Salt contamination of white pine planted adjacent to an interstate highway." Plant Disease Reporter, 54:1021-1025 (1970).

Sodium and calcium contamination of eastern white pine was determined for trees growing along Interstate 95 (Connecticut Turnpike) in an area that had received approximately 19,7000 kg of sodium chloride per two-lane km and approximately 840 kg of calcium chloride per two-lane km the previous winter. Twig plus needle growth of the previous year was sampled from roadside and away side branches of trees growing at varying distances north and south of the highway. Many samples had sodium concentrations greater than 1% (dry-weight basis), including several located more than 20 meters from the road. At least two samples had sodium contents equal to or greater than 1.9%. Sodium contamination was generally higher on trees growing south of the highway and on those samples taken from the side of the tree nearest the road. North of the highway, sodium contents decreased with increasing distance from the road. Calcium contents did not exceed normal calcium levels for white pine. White pine should not be planted closer than 35 m from high-speed roads in order to avoid injury from airborne salt.
Source: 7

#1194

Smith, W. H. "Trees in the City." AIP Journal, 429-436 (November 1970).

Conventional wisdom holds that forest or groups of trees can make living in a community more pleasant by reducing noise and air pollution, by making the climate less harsh, and by providing better water supplies. However, very few studies have been conducted to actually evaluate and quantify the capacity of community forests to provide amenity values. Most of the available information must be interpolated from investigations conducted for other purposes. Since many of these studies are really only marginally related, conclusions based on them must be interpreted with considerable caution.

Forests can reduce noise. They do so most efficiently if they are very dense. Stands of coniferous trees appear to result in greater attenuation than deciduous trees in full leaf. The ability of deciduous forests to mask sounds is probably quite low when they are leafless. Even in the case of dense, coniferous stands, distance between noise source and receiver must be quite large for meaningful noise reduction to occur. If, for example, we would like to reduce an urban noise level of approximately 50 db to one of less than 20 db characteristic of a quiet spot in the country, we might require a forest barrier approximately 500 to 2,000 feet wide. It is quite obvious that small groups of trees and narrow bands of woods will do little in reducing unwanted sound.

Trees can remove certain aerosol and gaseous air pollutants from the atmosphere. In the case of both classes of contaminants the leaves are probably the most efficient agents of subtraction. In New Haven, Connecticut, air pollution by aerosol and certain gaseous materials is considerably greater in the winter than it is during other seasons of the year (DeLouise, 1968). This would suggest that only coniferous species might be capable of reducing air pollution in a significant way. Whether forests do or do not cause

meaningful changes in air quality is not known. Sizes of polluting aerosols are extremely variable. Ability of plant leaves to hold particles of various sizes is not constant. Whether the quality and quantity of the aerosols removed is adequate to improve community air remains to be determined. The role of trees in lessening the amounts of gaseous pollutants is even less clear. A most critical need is to determine amounts of the various pollutants conifers are capable of removing relative to the amounts that may exist in agiven community's atmosphere.

The most positive microclimatic benefits a community may derive from a forest involve depression of summer air temperatures and reduction of winterwind velocities. These benefits probably do not extend any significant distance from the forest so that beneficiaries are only those actually living within or immediately adjacent to the forest. Presumably both deciduous and coniferous species would have the capacity to lower summer air temperatures. Coniferous forests may, yowever, have somewhat greater ability to lessen winter winds.

The contribution of forests to the water supply of an area is not one of quantity, but quality. Forests reduce water yields by evaporation but increase water quality by restricting amounts of dissolved and undissolved materials in effluent waters. Damage caused by floods resulting from minor storms may be lessened in areas of forest cover.

An interesting aspect of this brief review of forest amenity values is that some are incompatible and even mutually exclusive. A dense forest is extremely desirable, for example, for efficient noise reduction. Excessive density is undesirable, however, for a forest serving primarily as a windbreak. The processes of transpiration and evaporation are benefical for summer cooling as they utilize radiant energy that might otherwise be available for heating the air. These same processes, however, cause large amounts of water to be lost from wooded regions and may be viewed as wasteful in regions of limited water availability.

The case to be presented for the amenity values of forests is currently based on very limited evidence. Nevertheless, the evidence is sufficient to indicate the potential trees may possess to make our environment more livable. To extend the factual base for community planning, we must initiate research with evaluation of amenity functions of trees in urban areas as a specific objective. Special advanatage should be taken of opportunities for research in urbanizing areas. Efforts to insure that urbanareas have trees must be vigorously supported.
Source: 6

#150
Smith, W. H. "Lead contamination of roadside white pine." Forest Science, 17: 195-198 (1971).

Lead contamination of the growth of the previous year (twig plus needle samples) of eastern white pine was determined at various distances from an E-W section of an Interstate highway with a traffic density of approximately

24,000 vehicles daily. Lead contamination decreased regularly with increasing distance from the highway edge, was consistently higher on trees south of the roadway than on those to the north, and was generally greater on branches sampled from the side of the tree closest to the highway as contrasted with branches analyzed farthest from the road on individual test trees. Samples up to 15 m distance from the highway often were contaminated with more than 100 ppm lead, much of which was presumably impacted on exterior surfaces.
Source: 7

#679
Smith, W. H. "Lead and mercury burden of urban woody plants." Science, 176 (4040):1237-1239 (June 16 1972).

Branch samples were collected from Sept.-Nov. 1970 throughout the city of New Haven, Connecticut. The species surveyed were pin oak, sugar maple, Norway maple, eastern hemlock, yew, and Norway spruce. Portions of the samples collected for lead analysis were subjected to various washing procedures. All samples were then dried and ashed. The lead content was determined by atomic absorption spectrophotometry. Mercury determinations were made with unwashed specimens by means of a flameless adaptation of atomic absorption spectrophotometry after wet digestion. The average values exceeded most lead concentrations reported for trees, and the maximum values, exceeded all previously reported lead concentrations, even for trees in areas with geologic lead deposits. The highest lead concentrations were associated with twigs in sugar maple, eastern hemlock, yew, and Norway spruce and leaves in pin oak and Norway maple. The maximum lead concentration observed was 760 ppm in a washed hemlock twig. Washing procedures did not appear to affect the lead amounts. Also, ten unwashed samples of tree and shrub tissues collected in New Haven during the same period were analyzed for mercury. The mercury content of six of these samples slightly exceeded 0.5 ppm. Only one sample contained more than 1.0 ppm mercury. Woody plants may play an important role in heavy metal cycling in urban areas by acting as a short and long term respository.
Source: 6

#151
Smith, W. H. "Metal contamination of urban woody plants." Environmental Science & Technology, 7:631-636 (1973).

During the fall, 1970, leaf and twig tissue representing the growth of the previous growing season was collected from six woody plant species throughout the city of New Haven. Sugar maple was also sampled from remote northern New Hampshire and Vermont. These tissues were analyzed for Al, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Na, Sn, Zn, and V by atomic absorption spectrophotometry. Co and Sn were not detected. V was present in only a few samples from two city species. All other metals were found in all New Haven woody plants and in the sugar maples from remote areas. Cd, Cu, and Mn were present in "normal" amounts. Al, Cr, and Ni were present in "slightly above" normal amounts. Fe, Pb, Na, and Zn were present in "above normal" amounts. The mean Pb concentrations exceeded most Pb concentrations determined for trees in areas with geologic Pb deposits or adjacent to primary highways. Washing and analysis with an electron microprobe failed to provide conclusive evidence with regard to the specific location of the Pb on or in the tissue sampled.
Source: 7

#48
Smith, W. H. "Air pollution - effects on the structure and function of plant surface microbial - ecosystems." Presented at Advances in the Microbiology of the Aerial Surfaces of Plants. University of Leeds. Leeds, England. (September 1975).

Discusses the relationship between air pollution and plant surface microorganisms. The nature of the relationship between contaminants in the atmosphere and microbial organisms is divided into 3 classes based upon dosage: under conditions of low dose, class I, the microorganisms may function as a source or sink for air contaminants. Exposure to intermediate doses, class II, may adversely affect metabolism, etc. of organisms. These affects are described with examples. Exposure to high dose, class III, may stimulate, develop, or induce acute morbidity or mortality of individual microorganisms. This is also described. It is pointed out that plant surface microorganisms also contribute trace contaminants to the atmosphere. These volatiles may function in dissipating unneeded 2^{o} products of metabolism or in altering the microbial ES. The microbes may also function as a sink for certain pollutants and if microbial tolerance is great enough this sink may lower pollution loads generated by man.
Source: 7

#362
Smith, William H. "Lead contamination of the roadside ecosystem." Journal of the Air Pollution Control Association, 26(8):753-766 (August 1976).

The atmospheric, edaphic, and vegetative components of the roadside ecosystem contain elevated levels of lead originating from the combustion of lead containing gasolines by motor vehicles. The size of this ecosystem approximates 3.04×10^{7} hectares (118,000 square miles) in the United States. Recent evidence has greatly refined our understanding of the distribution and localization of lead in the roadside environment. This paper is a representative review of some of this recent evidence. Vehicles release approximately 80 mg of lead/km to the atmospheric compartment in the form of inorganic lead salts ranging in size from 1 to 5 μ. Lead content of roadside atmospheres may be elevated 2-20 times non-roadside atmospheres. Sedimentation from the atmospheric compartment results in lead contamination of the soil and vegetative compartments. Lead in the upper 5 cm of the soil profile may be elevated 30 times non-roadside soil within a few m of a street or highway. The soil lead is largely bound by organic matter exchange sites or present as the relatively insoluble lead sulfate. The increased lead burden of plants, largely due to surface deposition, may be 5-20, 50-200, and 100-200 times baseline lead levels for unwashed agricultural crops, grass, and trees respectively. Invariably most plant studies demonstrate a strong inverse correlation between plant lead level and sampling distance normal to the highway and a less strong, but direct, correlation between lead burden and traffic volume. While our appreciation of the distribution of lead in the roadside ecosystem is good, our understanding of its chemistry and the effects on the biota are deficient. Acute and direct impacts of lead on components of the roadside biota are not apparent. The potential for interactive effects with other stress factors and for subtle impact is considerable, however, especially in regard to plant surface and soil microbiota, foraging insects and animals, and plant leaf and root metabolism.
Source: 8

#893
Smith, W. H. "Lead contamination of the roadside ecosystem." J. Air Pollut. Contr. Assoc. (In press).

A comprehensive survey of all literature pertaining to lead in word and table format.
Source: 7

#86
Smith, W. H., Dochinger, L. S. "Capability of metropolitan trees to reduce atmospheric contaminants." (Presented at Better Trees for Metropolitan Landscapes Symposium, U. S. National Arboretum, Washington, D. C., November 1975).

The most damaging levels of air pollution are reached in industrial and urban areas. Atmospheric contaminants in metropolitan areas include both particulate and gaseous pollutants. Since trees have evolved in the presence of numerous materials presently considered air pollutants and as trees are frequently abundant in urban areas, it has been speculated that trees may function as effective sinks for trace contaminants in the urban atmosphere. Mechanisms for particulate removal may include sedimentation onto tree surfaces, impaction on tree surfaces and precipitation transfer to tree surfaces. Mechanisms for gaseous removal by trees may include uptake via plant pores and surface adsorption. Sufficient potential for this sink function is indicated to justify consideration of this amenity function in tree selection and breeding programs for metropolitan trees.
Source: 7

#1787
Sobotka, Alois. "Koreny Picea Excelsa L. pod vlivem prumyslovych exhalatu v oblasti krusnych hor." (Roots of Picea excelsa L. under the influence of industrial emissions in the FRZ Mountains region). In: Imise a Lesni Cenosy (Immissions and Forest Coenoses), Prague, Czechoslovak. Academy of Sciences, 45-52 (1968).

Biotic changes in soil components with respect to the effects of industrial emissions on the roots of spruce trees were studied. The seedlings in the damaged area of the stands were relatively weaker, and short roots from the damaged and undamaged areas differed slightly. The effect of air pollution on the short roots of the seedlings protected by the crown of mature stands was negligible. The short roots of maturing spruce trees, however, were considerably affected. The variability in the shapes of the roots in the damaged area increased, and the number of deformed roots increased with approach to the soil surface.
Source: 1

#680
Sokolowski, Aleksander W. "Wplyw na roslinnosc lesna zanieczyszczen powietrza emitowanych przez Zaklady Azotowe w Pulawach." (The impact of air pollutions emitted by the nitrogen plant at Pulawy on forest vegetation). Sylwan, 115(3):47-56 (1971).

The effect of nitrogen plant emissions on forestry was investigated at Pulawy, Poland. The plant emitted mainly ammonia, nitrogen oxide, and ammonium saltpeter. The forest tract was composed of pine trees with a sporadic mixture of common birch, durmast oak, and English oak. Early in 1967, the drying of pines in the forest around the plant was recorded. By the spring of 1968, more than two hectares of the forest had died, increasing to the serious destruction of 100 hectares by 1969 and obvious symptoms of ruin on some 700 hectares. The process of forest disappearance within the zone of high pollution concentration was quite rapid; forest associations died within one year. A treeless zone was formed, soon covered with garden weed species and plants. Some agricultural solutions are discussed.
Source: 1

#869
Solberg, Richard A. and Donald F. Adams. "Histological responses of some plant leaves to hydrogen fluoride and sulfur dioxide." Am. J. Botany, 43:755-760 (Dec 1956).

The effects of hydrogen fluoride and sulfur dioxide on plant leaves were investigated. Morpark apricot, Italian prune, and Winesap apple trees were fumigated eight hours daily, five days per week, at 5 ppb HF. Pinto beans and tomato seedlings were fumigated with 0.5 ppm SO2 and 5 ppb HF. Fumigations with a mixture of HF and SO2 were conducted with the same concentrations in combination. Samples of injured and control leaves were processed microtechnically and examined microscopically. Histological responses to HF and SO2 were indistinguishable. Microscopic injury was first apparent in the spongy mesophyll cells and the lower epidermal cells. The mesophyll cells were readily injured and the most common degree of injury was total collapse; the lower epidermal cells were observed to distort and collapse when the mesophyll cells did. Disintegration of the chloroplasts occurs in those cells injured by HF and SO2 before complete collapse of all the leaf tissues occurs. Various postulates are discussed concerning the means and pathways by which a phytotoxic air pollutant may enter the leaf and produce injury.
Source: 1

#1148
Solberg, R. A., D. F. Adams, and H. A. Ferchau. "Some effects of hydrogen fluoride on the internal structures of Pinus ponderosa needles." Proc. Nat. Air Pollut. Symp. 3rd. Pasadena. pp. 164-176 (1955).

Pinus ponderosa trees were submitted to fumigations of 0.5, 1.5, 5.0 and 10.0 p.p.b. hydrogen fluoride. Samples were taken and comparisons made of microscopic cross-sections of injured and uninjured (control) needles. Observations of fumigated needles yielded the following:

Over-all needle damage was in the form of browning of the needle apexes, which gradually progressed basipetally. Inward collapse of the interior needle surfaces was observed in all needles showing macroscopic injury. Microscopic changes in the green needle tissue, presumably due to fluoride, were observed only in the tissue immediately adjacent to macroscopically browned areas and were of an intermediate type.

The epidermis, hypodermis, and xylem tissues exhibited the least injury of the tissues studied. Extreme plamolusis in the two former tissues and parenchymatous cellular swelling in the latter tissue were observed.

The mesophyll cells exhibited granulation, vacuolation, and finally total collapse. The resin duct epithelial cells were observed to enlarge greatly, to the extent that duct canals were frequently occluded.

The endodermal cells showed a typical distortion in injured needles. The transfusion parenchyma cells enlarged greatly, resulting in distortion of adjacent tracheidal cells.

The phloem and xylem parenchyma enlarged greatly. Extreme needle damage showed the phloem to be collapsed against the xylem tissue.
Source: 5

#870
Spaeth and Meyer. "Beobachtungen uber den Einfluss des Leuchtgases auf die Vegetation von Baumen." (Observations of the effect of coal gas on the vegetation of trees). Landwirt., Ver. Sta., 1872(16):336-341 (1970).

Investigations on the effects of coal gas on the growth of trees are discussed. The trees were distributed over an area of 28.28 sq m; 1.545 and 0.772 cu m of coal gas were introduced to the soil daily. After four weeks of gas treatment, the buds of trees which were certain to die had a seemingly healthy appearance. However, a closer examination of the cross sections showed the buds of the plane trees, silver poplar, American walnut, tree of heaven, and acacia were completely dead. The buds of the maple trees and the horse chestnuts were still alive but had a brown discoloration on the inside. Only the buds of the linden trees still seemed normal. However, they did not sprout in the spring. A closer examination revealed that all roots, with the exception of a few strong main roots, were dead. A large quantity of coal gas, introduced to the roots while in a state of hibernation was much less harmful than a much smaller amount introduced during their growing period. Some species (tree of heaven, locust, elm, and acacia) showed signs of poisoning sooner, some (maple and linden) later.
Source: 1

#1246

Spangler, C., and N. de Nevers. "Benzo(a)pyrene and trace metals in Charleston, South Carolina (Final Report)." Environmental Protection Agency Rept., EPA-450/2-75-004, 57 p. (June 1975).

Measurements of benzo(3-4) pyrene and trace metals in the air over Charleston, South Carolina were performed in an attempt to explain an anomalously high incidence of deaths resulting from lung cancer in the area. Trace metal and B_aP level were lower than the national averages, generally falling in the 0.01 to 29 percentile among American cities. The lung cancer rate in Charleston was about 50% higher than the national average. Soil samples were also taken in Charleston at sites roughly corresponding to the area in which air was sampled to test the view that atmospheric concentrations of B_aP can readily be inferred from soil concentrations. The Charleston soil values of B_aP were not extraordinarily high. Thus, the abnormally high death rate from lung cancer in the area does not appear to be a result of high concentrations of B_aP or trace metals.
Source: 1

#955

Spedding, D.J. "SO_2 uptake by limestone." Atmos. Environ., 3:683 (1969).

Limestone was exposed to 100μgm^{-3} sulfur-35 sulfur dioxide in air for 1 hour at 70-80% relative hunidity. SO_2 was taken up almost completely by the matrix, while the fossils had little or no sulfur deposited on them. The SO_2 taken up by the matrix probably forms calcium sulfate which erodes in time by dissolution and mechanical stress. Two pieces of oolitic limestone were exposed to sulfur -35 SO_2 under differing humidity conditions. There is a differential uptake of SO_2 but with low humidity, this is limited to a few distinct sites.
Source: 5

#1591

Spedding, D. J. "Sulphur dioxide absorption by sea water." Atmos Environ., 6(8):583-586 (August 1972).

Laboratory studies were made to determine the deposition of sulfur dioxide on the ocean and its subsequent absorption. The absorption of SO_2 by sea water was measured using a small scale laboratory apparatus with a S-35 isotope of SO_2 at atmospheric concentrations. Sulfur (35) activity in solution was monitored by the scintillation flow cell and a single channel beta spectrometer, the data being recorded on a strip-chart recorder. The output from the pH meter was simultaneously displayed on the strip-chart. The velocity of deposition of SO_2 varied with gas flow rate reaching 1.44 cm/sec in turbulent conditions. Gas phase diffusion probably limits the absorption of SO_2 by sea water, and oceans may be a major sink for atmospheric SO_2.
Source: 1

#90
Spedding, D,J. "Uptake of sulfur dioxide by barley leaves at low sulfur dioxide concentrations." Nature, 224:1229-1231 (1967).

The primary factor controlling SO2 sorption by plant leaves is the degree of stomatal opening. Humidity acts to increase stomatal opening and SO2 uptake. Various other factors influencing gas uptake are discussed including external resistance and leaf surface area.
Source: 7

#1788
Spedding, D.J. and W.J. Thomas. "Effect of sulphur dioxide on the metabolism of glycollic acid by barley (Hordeum vulgare) leaves." Aust. J. Biol. Sci., 26:281-286 (1973).

Barley leaves (Hordeum vulgare) treated in exposure chambers with 5 ppm sulfur dioxide in the presence of radiocarbon-labeled carbon dioxide showed an accumulation of radiocarbon-labeled glycollic acid and radiocarbon-labeled sugar phosphates together with a decrease in radiocarbon-labeled sucrose and radiocarbon-labeled pigments when compared with untreated leaves. Dissolution of the SO2 in the aqueous phase within the leaf appeared to lead to the formation of alpha-hydroxysulfonates which inhibited the enzyme glycollate oxidase. The observed changes in radiocarbon distribution of sucrose, sugar phosphates, and glycollic acid also appeared to be possibly related to such an inhibition. Glycollate oxidase activity might possibly be affected by atmospheric SO2 before photosynthetic CO2 fixation.
Source: 1

#1791
Spierings, F. "Untersuchungen von Raucheinwirkungen durch Begasungsversuche." (Study of the effects of fumes through fumigation experiments). Forschung und Beratung, Reihe C, Wiss. Ber. u. Diskussionsbeitr. (Muenster), 5:56-63 (1963).

Fumigation experiments with controlled atmospheres of hydrogen fluoride and sulfur dioxide involving a number of grasses, plants, bushes, and trees, performed at the Institute voor Plantenziektenkundig Onderzoek in Wageningen (Holland), are described. These experiments were undertaken because of the damage from these pollutants to tulip and gladiolus crops. Experimental results with HF in the case of gladioli

were in agreement with observations in the field both as to symptoms of damage and differences in resistance of various strains, but this was not the case with SO2 where labratory and field results differed. HF was found to cause much greater damage than SO2 and some strains of both tulips and gladioli were found to be more pollution-resistant than others. The concentration range in the experiments for HF was from 0.015 to 0.2 ppm, for SO2 from 0.75 to 3.50 ppm. HF damage in ornamental monocotyledons can be quantitatively expressed by the injury index indicating the percentage length of the leaf rim where damage can be observed. SO2 damge is largely manifested by spots which are not easily measured. The degree of damage was expressed by the color difference between healthy and damaged leave in tomatoes, spinach, and endives, and was determined colormetrically on alchoholic solutions of leaf pigments. Thus a 6 hr exposure of spinach to 0.5 ppm SO2 resulted in 14% damage, exposure to 1 ppm SO2 in 27% damage from pollution. Resistant spruce trees, should under conditions of a mildly polluted atmosphere, should produce for 20 years longer than less resistant strains. In areas exposed to severe pollution, only deciduous trees should be planted.
Source: 1

#681
Spierings, F. "Method for determining the susceptibility of trees to air pollution by artificial fumigation." Atmos. Environ., 1(3):205-210 (May 1967).

An apparatus for testing the susceptibility of trees and shrubs to air pollution in their natural environment is examined. The specially constructed blower does not disturb prevailing climatic conditions because ambient air and the test gas are mixed and blown onto a branch of the tree; the blower is so set up that the branch to be fumigated is near the outlet and between two transparent plastic plates fixed on either side of the outlet. In preliminary experiments with trees fumigated with varying concentrations of sulfur dioxide, the apple and pear trees were susceptible to SO_2 and mountain ash, of the deciduous trees, was the most sensitive.
Source: 1

#1790
Spierings, F.H.F.G. "A special type of leaf injury caused by hydrogen fluoride fumigation of narcissus and nerine." Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, 87-89 (April 22-27, 1968).

The studies of injuries to monocotyledonous ornamental flowers, growing near a steel factory west of Amsterdam, gladioli and tulips artificially fumigated with hydrogen fluoride showed the same order of sensitivity as in the field. Tests in a fumigation chamber with different concentrations of HF resulted

in the following order of decreasing sensitivity; Ixia, Freesia, Crocus, Sparaxis, Fritillaria, Chionodoxa, Scilla, Muscari, and Galanthus. The symptoms of injury were an ivory-colored necrosis of leaf tips, or, in freesias, a marginal ivory-colored necrosis. Narcissus and Nerine bowdenii showed different symptoms; after the appearance of the ivory-colored leaf tip, the injured part of the leaf slowly extended and a yellow discoloration started close to the original necrosis. This area may stretch several times further than the injured tip.
Source: 1

#1789
Spierings, F.H.F.G. "Influence of fumigations with NO2 on growth and yield of tomato plants." Neth. J. Plant Pathol., 77:194-200 (1971).

Prolonged and short-lasting fumigations with nitrogen dixoide were carried out with tomato plants. Very young plants showed an increase in length a consequence of fumigations with 0.5 ppm for ten days. A concentration of 0.4-0.5 ppm applied during a period of 21-45 days also resulted in an increase in length and gave rise to the development of smaller leaves and shorter leaf petioles. Fumigations with a concentration of 0.25 ppm during the entire growth period caused a decrease in crop yield of 22%.
Source: 1

#872
Spierings, F.H. and H.G. Wolting. "Der Einfluss sehr niedriger HF-Konzentrationen auf die Laenge der Blattspitzen-Schaedigung und den Zwiebelertrag bei der Tulpenvarietaet Paris." (Influence of very low HF concentrations of the length of the damaged blade-tip region and on the bulb yield with the tulip variety Paris). VDI (Ver. Deut. Ingr.) Ber., 164:19-21 (1971).

In a gardening area outside of Amsterdam, damage to tulips and gladioli by hydrofluoric acid emission from an industrial plant located 8 km away was noted. The same symptoms occurred inside of hothouses where tulips were grown already early in the year. Since HF concentrations inside of hothhouses are normally considerably less than in the outside air, long-term tests were made with the tulip variety Paris which was known to be very sensitive. Inside a larger glass building, four specially designed exposure chambers, each of 30 cu m inside volume, were used for these experiments. For producing the noxious mixture of air and HF, air saturated with water vapor was forced through heated hydrofluoric acid, and then combined with a stream of purified outside air. Purification of the latter was effected by filtering for dust removal and passing through shell lime for absorption of gaseous impurities. The mixture thus obtained was equalized in a suspended nylon bag, and then admitted to the four chambers, where a change of atmosphere was taking place three times a minute. The outer air was either sucked in continuously, or alternatively a condition was established where nine tenths of the air was being circulated and one tenth drawn in. The HF concentration in the chambers was

checked by sample taking in two three-hour periods each day, using an impinger for subsequent analysis. Graphs of damage to the plants were plotted for conditions of 0.5, 0.7, 1.4, and 4.3 micrograms HF/cu m, with the number of weeks of exposure on the abcissa, and damage to blade points in cm on the ordinate. The increase of damage as a function of time was very small at 0.5 micrograms, but became very pronounced at the higher HF concentrations. A study on changes in the yield of bulbs in dependence of HF concentration revealed 100% yield up to 0.3 micrograms HF/cu m, falling off gradually to 55% at 4.0 micrograms HF/cu m air.
Source: 1

#1907

Stamatovic, S. and D. Milic. "Problems of air pollution in Yugoslavia." Air Pollution Proc. First European Congr., Influence Air Pollution Plants Animals, Wageningen, Netherlands, p. 255-258 (April 22-27, 1968).

The expansion of the nitrogen and phosphate fertilizer industries in Yugoslavia has caused an increase in fluor emissions, endangering plants and domestic animals. In affected areas, fluorosis has been observed in horses, cattle, sheep and goats. Its occurence is explained by the quantities of fluor measured in hay, straw, wheat, maize, and sunflower seeds. The intensity of the poisoning varies according to geographic location, climate, and animals species. Under normal condition, damages are restricted to a distance of about 5 km from the factories. A lead foundry has created the problem of lead accumulation in soil, water, and animals, particularly in ruminants. Lead poisoning has been observed in lambs but so far not in sheep. Sheep milk in the affected area contains an average of 132 gamma/100 g lead. About the same concentration is found in milk from cows, though no lead poisoning has been observed in cattle.
Source: 1

#1220

Stamatow, St. N. "Zu einigen bioklimatischen Fragen im Zusammenhang mit Luftverunreinigungen." (Some bio-climatic topics related to air pollution). Angewandte Meteorologie, 4:247 (November 1963).

Air pollution causes a significant change in ionization of air. Clean air contains 750-800 light ions/cm^3, and the same amount of heavy ions. The polluted air in cities contains only 100-300 light ions/cm^3, whereas the count of heavy ions increases to 10,000-20,000. Recent literature has shown that the human body reacts to the changed ionization. Observations in spas on the Black Sea have shown that diseases (such as bronchial asthma, bronchitis, and chronic emphysema) that are believed to be caused by changed ionization, and other climatic effects, can be effectively prevented or cured.
Source: 6

#682

Stas, M.E. "Fluoor-vergiftiging door rook-gassen en stof van een superphosphaatfabriek." (Fluorine poisoning from waste gases and dust emitted by a superphosphate plant: determination of F content from deposits in plants, drinking water, forage, and bones). Chem. Weekblad, 38:585-593 (1941).

An extensive review is given of the literature on detrimental effects caused by fluorine in plants, animals, and humans, as well as the literature on methods of determining trace amounts of fluorine in water, air, and various other locales. A report is given of an original study of fluorine determination in plants, rainwater, drinking water, plant life consumed by cattle, and the bones of cattle. Results obtained in the immediate vicinity (distances of + or 100 m and + or -300 from the fertilizer factory) were compared with control results from other locales. The water, grass, and hay consumed by the cattle contained high amounts of fluorine, and that the bones of cattle that died with the symptoms of fluorine poisoning contained a higher fluorine level than other cattle.
Source: 1

#520

Staxang, B. "Acidification of bark of some deciduous trees." Oikos, 20(2): 224-230 (1969).

Bark samples of deciduous trees were collected in three provinces in southern Sweden, and tested for pH. Buffer curves were also obtained. In those trees where the bark under unaffected conditions is not strongly acid, a clear tendency is evident towards greater acidity in Skåne and to a smaller extent also in Bohuslän than in Uppland. As local sources of air pollution were avoided, the acidification must result from the increasing general acidification of W. European air and precipitation.
Source: 2

#1699

Steenken, Folkhard. "Benelungsversuche von Nutzpflanzen mit Bleisalzen aus Autoabgasen." (Fogging experiments on cultivated plants with lead salts from automobile exhaust gas). Z. Pflanzenkrankh. Pflanzenschutz., 80(6): 346-358 (1973).

Fogging experiments with lead (II) salts contained in automobile exhaust gas as well as with lead nitrate and lead acetates showed on all tested plants very homogeneous lesions: on older leaves 2-3 days after the treatment with solution greater than 100 mg Pb (II) I blackish blisters are produced symmetrically distributed over the leaf blade (lamina). At these spots the cell walls, especially at the palisade layer contiguous to the respiratory cavity, are considerably thickned and blackened. These cells die. Underneath, however, a wound cambium is developed. These injury pictures correspond very much to those which are caused by ozone. On young leaves such blisters are missing. In most cases only the leaf tips are decolorized. Not totally developed leaves are less sensitive against Pb salts than older

ones. Plants which are grown during winter in a greenhouse have a lower resistance against equimolar Pb solutions than the corresponding outdoor plants. The quantitative injury effect of the Pb salts depends furthermore on the concentration as well as their solubility resp. stability in water. Lead nitrate proved to be the most injuring substance. The longer the Pb salts react on the leaves the lower is the proportion of washable lead. Three days after the treatment 65%-70%, 21 days afterwards only 35-40% could be washed off with water, ethanol, or either. But from a leaf of red cabbage 30 days after the application still 80-90% of the lead is removable with a watered sponge. Thirty days after the application approximately 3% of the total Pb is infiltrated through the stomata into the mesophyll. A translocation of the lead compounds from contaminated leaves into developing, uncontaminated organs (leaves, fruits) does not occur.
Source: 1

#1698
Steenken, Folkhard. "Begasung von Nutzpflanzen mit bleihaltigen und bleifreien Autoabgasen." (Fumigation of cultivated plants with lead-containing and lead-free automobile exhaust gases). Z. Pflanzenkrankh. Pflanzenschutz, 80(9/10):513-527 (1973).

The direct fumigations of cultivated plants in greenhouses with automobile exhaust gas caused widespread intercostal partly lethal destruction especially of older leaves. Young leaves were only slightly injured. Between those plants fumigated with lead-containing motor emissions and those fumigated with motor emissions free of lead no distinguishable leisions appeared. These plants did not show the lead-injury symptoms known from the fumigation experiments. The chief injury components are gaseous, primary and secondary reaction products of the automobile exhausts. The plants treated with automobile exhausts free of lead were more severely injured at most of the exposures than those fumigated with lead containing exhausts. The fresh and dry weight, each determined 3 weeks after the last exposure, and the weight of the fruits however, were relatively balanced in both test series. Although the test plants contained up to 350 mg lead/kg dry matter, these concentrations did not lead to any statistically demonstrable depressions of yield or growth. In the adaptation experiments the plants grown up in relatively low amounts of atmospheric pollution first showed a highly significant decrease of growth compared with the control plants. However, after growing further in exhaust-free air, the injured plants reached the same stage of development after 28 days. The adaptability was verified by the end fumigations executed with high concentrations. It proved that the longest adapted plants had acquired the greatest resistance against the automobile exhausts. An adaptation effect could only be obtained by longer lasting continuous action. Short-term fumigations remained unsuccessful.
Source: 1

#683

Stefan, K. "Der Wert von Luft- und Nadelanalysen fuer die Rauchschadensfeststellung." (The value of air and needle analyses for smoke damage determination). Presented at the Symposium on Smoke Damage to Forests in Austria, Vienna, Austria. Mitt. Forst. Bundesvers, 73:91-99 (1966).

For air analyses, quantitative and qualitative long-term methods, rapid methods, continuous and intermittent, and recording methods can be applied. Qualitative long-term analysis does not reveal the actual time the emission occurred and the frequency of toxic concentrations. The rapid and recording methods deliver data on the absolute concentration and the frequency of toxic concentrations. The latter methods should, however, be preceded by a general survey, applying long-term methods. Formulae for determining stack height only apply to plain areas with no forests. Threshold values cannot be regarded as fully reliable. The threshold of 0.5 mg/cu m for sulfur dioxide may be too high for certain plants. For sulfur dioxide, leaf analyses are not fully reliable due to the inherent SO_2 content and the lack of a direct relationship between emission intensity and leaf SO_2. Fluorine analyses yield, however, unambiguous results. The samplings should be completed within a relatively short period, and in the same vegetation periods for analyses extending over a number of years. Due to different sensitivities and influencing factors, the intensity of the damage cannot be determined from SO_2 and fluorine analyses. Consequently, representative forest age and comparable test areas are principal sampling criteria. While air and needle analyses unambiguously reveal the fact of emission, the actual damage can only be determined from growth measurements.
Source: 1

#871

Stefan, K. "Die Beinflussung des Gesamtschwefelgehaltes von Fichtennadeln durch Dungung." (The influence of fertilization on the total sulfur content of spruce (fir) needles). Air Pollution Proc. First European Congr., Influence Air Pollution Plants Animals, Wageningen, Netherlands, (1968).

An experimental program designed to determine the effect of fertilization on the sulfur content of spruce needles is described. Needles taken from trees damaged by sulfur dioxide were analyzed to determine the characteristics of the sulfur content. The natural sulfur content of needles and its variation were determined before the fertilization process was begun. Fertilizers of two types, nitrogenous and sulfurous, were applied to controlled groups of trees. The change in sulfur content of the needles as a result of the sulfurous fertilizer was determined. The overall effect of the fertilization was a decrease in sulfur content of all the treated trees. However. the results were diverse and it is likely that they were influenced by location. The analytical method used to determine the sulfur content of the needles is described.
Source: 1

#1700

Stefan, K. "Ueber den natuerlichen schwefelgehalt von fichtennadeln und seine bedeutung fuer die rauchschadensdiagnose." [The natural sulfur content of pine needles and its significance for pollution damage assessment]. Polska Akademia Nauk. Zaklad Badan Naukowych Gornoslaskiege Okregu Przemyslowego. Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 297-312 (Sept. 9-14, 1968).

Sulfur content and its fluctuations were determined in one-, two-, and three-year old pine needles from five different localities. The sulfur level of all needles tested varied between 0.033 and 0.079% S/dry matter and hardly changed over a period of several consecutive years; differences between median yearly levels of needles from the same locality were not statistically significant. The yearly fluctuation in the S content of individual trees was plus or minus 0.02% S/dry matter, that between different trees was 0.036% S/dry matter. There were significant differences in the sulfur content of pine needles from the five localities being studied, attributable to environmental differences and different characteristics of individual trees. Two-year old needles had an 0.11% natural sulfur content, three-year old needles a 0.13% content in dry matter. The yearly fluctuation of the sulfur content of these needles was plus or minus 0.02% S. Indication of SO2 emissions into the atmosphere can be derived from increases in the sulfur content of needles above their natural levels or from increased annual fluctuation rates.
Source: 1

#1697

Stefan, K. "Nadelanalytische Ergebnisse von Einem Duengungsversuch in Einem Rauchgeschaedigten Fichtenbestand." (Results of needle analyses from a fertilizer trial in a smoke-damaged Norway spruce stand). Presented at the International Symposium of Forest Dume Damage Experts, 7th, Essen, West Germany, Sept. 1970. Mitt Forst. Bundesvers., 97:521-534 (1972).

To investigate the effect of fertilizing in fume-damaged areas, a fertilizer trial was conducted in 1968 in Aichfild, Steiermark (Austria) in a pole-size Norway spruce stand. The trial area comprised eight plots, of which four remained untreated and four were fertilized with various combinations and amounts of fertilizer. One pair of plots (IV) was on a higher terrace (15 m above the rest of the plots). Nutrients were applied in varying amounts to the plots in the spring of 1969. Needle samples were taken in October of 1968 and 1969. The nitrogen, potassium, phosphorus, calcium, and magnesium content were determined in the first year's needles from two trees in each plot; the sulfur content was determined in the 1 to 3-year needles. As a result of the fertilizer treatment, there was a significant drop in the sulfur content of the 1-year needles (up to 39% relative). In the older needles, the reductions were smaller. The data for the sulfur values for 1968 (plots I through III) and the untreated plots for 1969 (plots I through III) were also evaluated to see how large the deviations of an individual value could be from the area mean value, and to see how this error can be reduced by analyzing more samples and using their mean values. The extent to which the maximum deviations from the area mean value are reduced by this procedure are presented.
Source: 1

#684
Stefan, K. and J. Pollanschuetz. "Entstehung und Entwicklung eines Rauchschadengebietes in der Umgebung eines Magnesitwerkes." (Formation and development of smoke damage in the neighborhood of magnesite factory). Allg. Forstz., 78:51-54 (1967).

Systematic investigations of the effects of a magesite factory on nearby forests are described. Needle and leaf analyses, measurements of dust build-up, and radial and vertical growth rates were carried out in different points over a period of four years. In 1959, the daily sulfuric acid emissions ranged from 0.06 to 0.25 mg, while the yearly averages for the period of 1961-1964 were 0.56; 0.95; 1.15, and 0.60 mg/day. The yearly maxima were 1.2; 2.1; 2.8 and 1.4 mg/day. The points of maximum emissions were southeast of the plant. For the same period, the yearly averages of the sulfur content in the needles were 292, 310, 339, and 170 mg % H_2SO_4; areas northwest of the plant gave the highest values. Dust emissions were higher in southeast than in northwest areas. A maximum of 0.08 g/sq m day occurred in 12 measurements. Growth measurements revealed chronic damage with persistnetly reduced rates of growth. The different rates of growth were affected by wind direction. As uniform SO_2 concentrations and highly different dust concentrations resulted in the same degree of growth retardation, the negative effect of magnesite dust was regarded as unimportant. Firs were the least affected of all trees. As opposed to coniferous trees, the rate of growth of beeches increased considerably in the emission-affected area. This may be explained from the possible fertilizing effect of magnesium sulfate on the leaves.
Source: 1

#1701
Stefanson, R.C. "Evolution patterns of nitrous oxide and nitrogen in sealed soil-plant systems." Soil Biol. Biochem., 5(1):167-169 (Jan 1973).

Evolution patterns of nitrous oxide and nitrogen in sealed soil-plant systems are discussed. Sealed growth chambers were used to measure the effects of soil organic matter content, soil water content, and the form of applied nitrogen and plant growth on the evolution of nitrous oxide and nitrogen. Samples of red-brown earth were collected from two sites in the air-dry condition and passed through a 0.6 cm rotary sieve. These soils were packed in plastic pots to a density of 1.45 g/cu m, and an amount of nitrogen was added with sufficient water to bring the soil to the required water content. The internal atmosphere of the chamber was sampled daily for the first 10 days and then three times/week. Pre and post-experimental analysis showed that the only major products of denitrification in the chambers were N_2O and N_2. Soil organic matter content, soil water content and plant growth did not greatly affect the relative gas composition.
Source: 1

#1702
Stein, G. "Der Einfluss von industrieabgasen aus dem Boehmischen Becken auf die Waldgebiete im oberen Erzgbirge." (The influence of industrial waste gases from the Bohemain basin on wooded areas in the Upper Erzgebirge.) Text in German. Meteorol, 20(1-6):106-108 (1968).

Progressive forest damage has occurred in the upper regions of the Erzgebirge (East Germany and Czechoslovakia) for the last decade due to industrial waste gases and especially sulfur dioxide originating from power plants and other industries in the Bohemian Basin. The damage manifests itself in premature loss of needles, progressive thinning out, and death of entire stocks of spruce, involving all age brackets. The serious damage area amounts to 11,000 ha in Czechoslovakia and 1000 ha in East Germany, while the entire smoke-damage area isover 50,000 ha in Czechoslovakia and 15,000 ha in East Germany. Systematic air pollution monitoring has demonstrated daily average SO_2 concentrations over 0.70 mg/cu m with peaks reaching 3 mg/cu m, and dust settling rates of 32 g/sq m/mo. The snow pH was around 6. The extensive and serious damage calls for thorough regional planning in cooperation between the two countries.
Source: 1

#1704
Steinhuebel, Gejza. "Zur Dynamik der Resistenz und einer Herabsetzung der Versorgungsmoeglichkeiten der wachsenden Triebe infolge Bestaubung bei Immergruenen." (The dynamics of resistance and the decline in nutrient supply of growing shoots resulting from a dust cover of evergreens). Polska Adakemia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p. 163-171 (Sept 9-14, 1968).

The relationship between vitality and resistance to emissions was studied on evergreens by covering laurel plant leaves with artificially applied dust from non-toxic particulates emitted by the blast furnaces of Ostrava in Czechoslovakia, to determine the difference in the degree of exhaustion of leaves (loss of dry weight) by age and season and the degree to which the dust cover exacerbated exhaustion. The dry weight of dust-covered and dust-free halves of the same leaf with identical light exposure were compared. During the vegetation period laurel leaves lost weight in the course of the day, indicating that disimilation and transport to shoots or buds exceeded the gain from photosynthesis. The highest dry weight losses were recorded on the oldest leaves. This condition persisted until the complete maturation of the fruit. Dust cover intensified leaf exhaustion by 25% to more than 100%. Higher temperature had a similar effect.
Source: 1

#1703

Steinhuebel, Gejza. "Die Beeinflussung der Translokationen organisher stoffe in den Wachsenden trieb durch feste Immissionen bei Koniferen." (The effect of solid pollutants on the translocation of organic substances in the growing shoots of conifers). Mitt. Forst. Bundesvers., 97:419-430 (1972).

The effects of solid pollutants may not always be direct. Organs such as young shoots, flowers, and fruits, for example, which rely on the translocation of assimilates from the places where they are produced, are not only directly injured by pollutants, they are also indirectly affected by the inhibition of the translocation of assimilates. The organs supplying the assimilates, which in evergreen broadleaved species and conifers are the photosynthetically active leaves and needles of the previous years, exhibit a reduced rate of photosynthesis due to dust; they are also exhausted by the removal of increased amounts of organic products and fall earlier than normal, even in the absence of toxic pollutants. The increased exhaustion of old dust-coated leaves of broad-leaved species by the translocation of assimilates during the spring extension growth has already been shown, and the experiment on conifers (Abies grandis) has been repeated. In the spring of the current year, the exhaustion of the previous year's dust-coated and non-dusty needles of Pinus nigra were determined by means of the modified half-leaf method of Sachs and the modified method of Ivanov and Kossovich. Source: 1

#1207

Stepan, Jan. "Bioindikatoren in der Landschaftsoekologie (im Rahmen der Gebiertsplanungspraxis)." (Bioindicators in landscape ecology (within the framework of territorial planning)). TERPLAN-Statni ustav pro uzemni planovani, Ustav krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiny, Sbornik Z Mezinarodni Konference, Prague, Czechoslavakia, p. 126-133.

General problems and possibilities of the use of biological indicators of landscape deterioration in territorial planning areas are discussed. Bionindicators signaling the negative anthropogenic influence on the environment now permit objective data for territorial planning decisions to be obtained. While the biological indication of the excess or deficit of certain elements and compounds in the soil is possible by means of indicator plants, the effect of a multitude of simultaneously acting factors, which is the case usually in practice, is very hard to detect in a specific manner. Examples of negative anthropogenic factors and their biological indicators are presented. Disappearance of certain plant species, reduction of plant production, and degradation of the original vegetation were observed in highly polluted areas. Source: 1

#158
Stephens, E.R. & W.E. Scott. "Relative reactivity of various hydrocarbons in polluted atmospheres." Amer. Petroleum Inst. Proc., 42:665-670 (1962).

Relative reactivity of various hydrocarbons in polluted atmospheres. E. R. Stephens and W. E. Scott (Univ. of California, Riverside). Proc. Am. Petrol. Inst., Sect. III 42 665-70 (1962). Rates of oxidn. of individual hydrocarbons with NO_2 in air were investigated using infared radiation to simulate the photochem. active portion of sunlight. Products of the reaction are aidehydes and peroxyacetyl nitrates (PAN), components that cause eye irritation common to smog. Peroxyacetyl nitrates formed with all of the hydrocarbons tested, except C_2H_4 which does not have the required Me group. Oxidn. reactivity of the hydrocarbons follows the order: olefins, aromatics, paraflins, and naphthenes. C_2H_2 was almost nonreactive. Some overlap in reactivity between types of hydrocarbons exists; for example, the most reactive aromatics (polyalkyl benzenes) are more reactive than the least active olefin (C_2H_4). Reactivity of olefins and alkyl aromatics is similar, indicating similar mechanisms. The addn. of alkyl groups increases the reactivity. The lab. tests were confirmed by measuring the rate of disappearance of different types of hydrocarbons in samples of polluted air exposed to sunlight.
Source: 7

#1705
Stephens, G. R., L. Hankin, and W. D. Glover, Jr., "Note on lead emissions from incinerated sewage sludge detected on tree foliage." J. Air Pollution Control Assoc., 22(10):799-800 (October 1972).

Lead emissions from incinerated sewage sludge were detected on tree foliage. Foliage of trees growing at varying distances and directions from incinerator stacks of two facilities was sampled. Foliage was also sampled along the highway about 2 mi from Facility 1 because it was within 20 yd of a highway. The average daily loss of Pb at Facility 1 was 0.7 lbs; losses ranged from 0 to 1.4 lbs. At Facility 2 only 0.26 lbs. of Pb was lost. In all of the foliage analyzed Pb was present in lrage quantities only in the vicinity of Facility 1. The quantity of Pb on foliage near Facility 1 varied with distance and direction from the incinerator stack and the highway. The Pb content of the samples averaged 69% higher than the samples taken 2 mi north of the incinerator. The Pb content of tree foliage surrounding Facility 2 was about half that found along the highway north of Facility 1 and about a third of that found on trees around Facility 1.
Source: 1

#1706
Stephens, G.R. and P.E. Waggoner. "Carbon dioxide exchange of a tropical rain forest. Part I." BioScience, 20(19):1050-1053 (Oct. 1, 1970).

Measurements were made of the metabolism of a Costa Rican premontane wet forest. Leaf area of the forest, respiration of leaves in the dark, the photosynthesis of leaves at various illuminations, and the carbon dioxide compensation concentration of leaves are discussed. A leaf area per land area, LAI, of 3 in the Bosque de Florencia places it among the common, neither hindered by a paucity of photosynthetic apparatus nor burdened by a surplus of respiring tissue. The carbon dioxide compensation concentrations of 40 to 80 ppm are not unusual, indicating that respiration during photosynthesis taxes the net assimilation of the leaves in this wet forest much as it does in other forests and crops. Respiration of the leaves from the upper and middle strata lies well within the range of 0.4 to 3.4 mdh found in a tabulation of eight species; respiration rates of the understory plants in the Bosque are remarkably slow. Net photosynthesis rates of the leaves of species in the Bosque and their response to varying illumination match those of plants from the temperature zone. Except for the pioneer Cecropia, however, observations of photosynthesis in species of either main canopy or understory are less than those reported for similar strata of the evergreen seasonal forest of southwest Cambodia. It is concluded that the Bosque de Florencia is neither unusual nor highly productive.
Source: 1

#1072
Stephens, G. R., et al. "Lead emissions from incinerated sewage sludge detected on tree foliage." J. Air Pollut. Control Assoc., 22:799 (1972).

Emission of heavy metals occurs due to the incineration of sewage sludge from industrialized areas, and emitted lead can be detected on the foliage near the incineration point. The experiment was conducted with the sludge from two sewage treatment plants in industrial areas. Lead due to automobile exhaust was taken into account.
Source: 5

#1707
Steubing, Lore. "Plants as indicators of air pollution." Provincia de Buenos Aires (Argentina), Comision de Investigaciones Cientificas, Reunion Probl. Efluentes Ind. Contam. Ambiental, La Plata, Argentina. p.27-33 (July 12-17, 1971).

Plants as indicators of air pollution are discussed. With the aid of physical apparatuses and chemical methods the concentration of gases and particulate matter in the atmosphere can be accurately measured. The visible injury symptoms on plants attributable to air pollution are leaves with necrotic spots and final collapse of the tissue, loss of chlorophyll, and growth alterations. Lower plants, mosses, algae, and some lichens were investigated to determine air quality and to identify pollutants in three German cities. Observations were made on lichens appearing on the trunks of

roadside and park trees. Chemical analyses were made on the lichens from the natural environment, where five zones of abundance were established (from Zone I -- lichen-free, to Zone V -- normal lichen vegetation), and under controlled conditions in a climate gas-box where the relation of sulfur dioxide to humidity was investigated. The effect of dust on living cells was also studied by the Mnium test, which utilized the moss Mnium punctatum. All results are presented.
Source: 1

#1129
Steubing, L. and R. Klee. "Comparative investigations into the dust filtering effects of broad leaved and coniferous woody vegetation." (German). Agnew. Bot., 44(1/2):73-85 (1970).

In the City of Frankfurt, the deposit of particulate matter from the atmosphere on *Rhododendron catawbiense* and *Pinus mugo* was measured quantitatively. *Pinus* had a significantly higher filter effect than *Rhododendron* for the water soluble as well as for the insoluble part of the dust. In comparative experiments in which dust was applied to open hedgerows of *Carpinus betulus* and *Picea abies* there was the largest sedimentation on the upper branches of *Carpinus* while in the middle and lower regions the deposit of dust was greater on *Picea* than on *Carpinus*. For the quantitative determination of the natural dust particles on plants a gravimetric method was developed; for measuring the particle deposition in artificial dusting experiments a colorimetric procedure is described. The amount of dust in mg/100 cm^2 was used as a standard. For the calculation of the surface of the needles of *Pinus* a special techniques was worked out.
Source: 8

#1708
Steubing, Lore, Rainer Klee, and Ulrich Kirschbaum. "Beurteilung der Lufthygienischen Bedingungen in der Region Untermain mittels niederer und hoherer Pflanzen." (Evaluation of air hygienic conditions in the Lower Main Region by means of lower and higher plants). Staub, Reinhaltung Luft, 34(6):206-209 (June 1974).

Mapping of the natural growth of epiphytic lichens and evaluation of the injuries of explants of Hypogymnia physodes yielded three lichen zones in the Lower Main Region which corresponded to the extent of atmospheric pollution. Zone I covers the three most polluted areas of the Lower Main Region, Frankfurt, Hanau and Eddersheim-Ruesselsheim. Typical is the oval expansion in a northwestern direction, which can be explained by the prevailing winds from the southwest. The visible injuries of the explants are functionally correlated to the chlorophyll destruction. The sulfur concentration, conductivity and osmotic value of spruce needles of spruces exposed in the center of Frankfurt and in the suburbs was determined. The results of these tests revealed the heavy sulfur dioxide pollution of the center of Frankfurt. In addition, the dust fall was measured with Bergerhoff units which were

set up in the two zones entirely unobstructed and in the midst of rhododendrons. The spring (May) measurements in the city center yielded a dust concentration of 310 mg/100 sq cm in 30 days for the unobstructed Bergerhoff units and 612 mg/100 sq cm/30 days for the rhododendron surrounded units. In the suburbs, the determined values were 48 mg for the unobstructed units and 37 mg for the rhododendron surrounded units. In November, dust concentrations of 695 mg (unobstructed) and 1006 mg (rhododendron surrounded) for the city center and 108 mg as well as 111 mg/100 sq cm 30 days for the suburb were measured.
Source: 1

#1709
Stewart, Joseph K. and Frank Matoba. "Some factors influencing the susceptibility of lettuce to CO2 injury." Plant Disease Reptr., 56(12):1051-1054 (Dec 1972).

The differences in susceptibility to injury increased concentrations of carbon dioxide, a normal respiratory product, in various lettuce cultivars were investigated. Lettuce was grown under commercial conditions, and the different lettuce varieties were exposed to determine CO2 tolerance. The lettuce grown in the Salinas Valley was more susceptible to CO2 injury than that grown in the desert areas or in the San Joaquin Valley. Different test lots and cultivars also differed within a given production area.
Source: 1

#1710
Stewart, W.D.P. "Algal metabolism and water pollution in the Tay Region. XVI." Proc. Royal Soc., Edinburgh, Sect. B, 71(2/4):209-224 (1971/1972).

Algal species composition and metabolism in lochs draining into the river Tay were investigated to provide a baseline for future studies of water pollution caused by increased Scottish east coast industrial activity associated with the North Sea oil boom. The Tay is currently the least polluted of major British rivers; runoff from agricultural land and input from domestic sewage are the main sources of input of waste products or nutrients. Rich blooms of algae, particularly blue-green algae, were present in many lochs, indicating that the waters are already mesotrophic or eutrophic. Combined nitrogen levels were appreciable but not sufficiently high to prevent nitrogen fixation. Phosphorus levels were particularly high and in excess of the requirements for algae growth. In the Tay estuary, there was no extensive algae development and little evidence of excess accumulation of nitrogen and phosphorus. Input of nitrogen and phosphorus from agriculture and urbanization may actually be beneficial by stimulating increased primary production in the Tay. Bioassay tests showed the presence of toxins inhibitory to algal metabolism in inflow waters to the Tay. While the nature of the toxins was not elucidated, high mercury levels were measured in a region of the Tay estuary. Air pollution, estimated by inhibition of nitrogenase activity on incubating the lichen Lichina confinis in air samples, was appreciable in Dundee but negligible in surrounding areas.
Source: 1

#996
Stewart, W. S., and D. H. Wilken. "A report on the effect of shade trees on 'smog'." Lasca Leaves, 16:84-86 (1966).

Measurements were taken at Los Angeles State and County arboretum (no numerical figures available) to determine the influence of plants on smog. Air samples were taken 2' above and 2' below the leaf canopy. These were significantly less oxidants in the shade, when there was low air movement; while there was no difference in pollutants above and below the canopy with a strong breeze. Use of opaque objects were then used, rather than a vegetative canopy, and similar results were obtained. This suggests that some of the undesirable effects of smog are caused by direct sunlight and can be reduced by (1) planting shade trees, (2) building patios, trellises, etc. to produce shade areas.
Source: 5, 6

#22
Stewart, W. S. and D. F. Wilken. "Effect of shade on atmospheric oxidants (smog)." Environmental Protection Agency. 11 pp.(No date).

A series of experiments utilizing atmospheric smog were conducted comparing simultaneously the oxidant level in sunlight and under shade, i. e., cardboard boxes and glass air chambers. Similar measurements taken under selected tree canopies. In comparison to sunlight, oxidant reduction occurred in all samples taken from the shade chambers and also was observed in the shade under the canopy. Highest reduction was observed in the cardboard box, presumably because of its greater volume. Temperature was not a factor. Author concludes that planting shade trees and other vegetation or creating shade artificially will reduce smog effects.
Source: 6

#1711
Stoeckhardt, A. "Untersuchungen ueber die schaedliche Einwirkung des Huetten- und Steinkohlenrauches auf das Wachsthum der Pflanzen, insbesondere der Fichte und Tanne." (Studies on the harmful effect of smoke emissions from metallurgical plants and coal firings on the growth of plants, especially of pine and fir). Tharandter Forstl. Jahrb., 21:218-254 (1871).

Cases of forest damages due to metallurgical plant emissions, and experiments on the effects of sulfur dioxide, arsenic, lead oxide, soot, and coal smoke on various plants are described. Gradually decreasing timber production and damaged trees in a coniferous forest near a metallurgical plant were observed. Snow, soil, and needle samples contained sulfuric acid, lead, and arsenic. Smoking tests revealed that SO2 in concentrations harmless for plants in short time exposure may be harmful in chronic exposure, and that deciduous trees are the least sensitive, followed by most agricultural plants, while conifers are most sensitive. A SO2 concentration of 0.0018% by volume rapidly damaged wheat, oats, and peas, while a smaller concentration of 0.00135% was fully ineffective. Arsenic in the form of vapor was much less harmful than in the form of solutions absorbed by roots or stems; its effect was negligible compared with that of SO2. Lead oxide caused no damage to the test plants, and neither did soot in itself, which indicates that practical damage from soot is attributable to its SO2 content. While wood smoke was harmless for plants, plant damage due to coal smoke was traced to the sulfur content in such fuels.
Source: 1

#953
Stoiber, R.E. and A. Jepsen. "Sulfur dioxide contributions to the atmosphere by volcanoes." Science, 182:577-578 (1973).

The first extensive measurements by remote-sensing correlation spectrometry of the sulfur dioxide emitted by volcanic plumes indicate that on an order of 10^3 metric tons of sulfur dioxide gas enter the atmosphere daily over Central American volcanoes. Extrapolation gives a minimum estimate of an annual amount of sulfur dioxide emitted from the world's volcanoes of about 10^7 metric tons.
Source: 5

#686
Stratmann , H. "Ermittlung vegetationsgefaehrdender SO2-Immissionen." (Determination of atmospheric SO2 concentrations that are dangerous to plant life). Landwirt. Forsch. Sonderh., 17:13-16 (1963).

Over the past few years, significant research into the effects of sulfur dioxide on agricultural plants and trees has been carried out at 2 centers; the Air Pollution Control Research Institute at Essen and the Farbwerke Hoesch Research Station at Hattersheim. The Essen group have experimented with exposure to gases in climate-controlled rooms and in the open air, while the Hattersheim group have conducted their experiments in small greenhouses. Controlled climate experiments indicate that the reaction of the plants is not simply proportional to the product of gas concentration and exposure time,and the degree of damageinflicted increases in proportion to this product as the concentration itself increases. A determining factor is the fact that plants, even when kept in a controlled climate, undergo a diurnal cycle of sensitivity. High concentrations for a shorter time do more damage than low concentrations for a longer exposure time, indicating the existence of concentration peaks. Although most cultivated plants are resistant to night exposure, a night exposure immediately following a day light exposure causes a multiplication of damages, as does a succession of peak concentrations. Plants whose leaves are not fully developed suffer a higher degree of SO_2 damage than those whose leaves are fully matured. In the case of deciduous trees, sensitivity increases in proportion to the development of the leaves, until full leaf maturity is reached: this is the peak of the sensitivity cycle. Older trees are more resistant to SO_2. In defining terms, a differentiation is made between immediate damage to plants (such as leaf damage) and ultimate damage (such as to the yield at harvest time). The influence of immediate damage on ultimate damage can vary, depending on the stage of development or sensitivity cycle of the plant in question.
Source: 1

#687
Street, O.E., C.H. Sung, and H.Y. Wu. "Studies on weather fleck of tobacco in Taiwan." In: Taiwan Yen-Chiu Chuan-mai-chii yen-tsao yen-chii-so nien pao, (Taiwan Tobacco-Wine Monopoly Bureau and Tobacco Research Institute Annual Report), Taiwan Tobacco-Wine Monopoly Bureau and Taiwan Tobacco Research Inst., Taichung, p. 67-74 (1970).

Thirty varieties of tobacco were studied for weather fleck due to air pollution. Leaf injury estimates were made at or near plant maturity. Six types of leaf injury were observed. Of these, five represented slight variations of spotting and weather fleck. Havana 142, a cigar binder, was the least damaged variety; Burley 49 was the most severely damaged. The plant was unusually small resulting from ozone injury. Damage to the check variety, Vam-Hicks, was relatively severe. The best of the flue-cured tobaccos was Speight G-3; Burley 21 was the best in the Burley tobaccos. The Md. 64 was the best of the Maryland tobaccos tested. Bel W-3 was not the most severely damaged variety, which did not agree with results obtained in the United States. Otherwise, results of both studies were similar.
Source: 1

#1712
Subido, P.S., P.A. Santamaria, E.N. Alqueza, and A.C. Pizarro. "Plants injured by air pollutants." Philippine J. Sci. (Manila), 98(3/4):323-328 (Sept/Dec 1969).

The effects of emissions from a fertilizer factory on the plant life in the surrounding areas were examined. The typical symptoms and condition of the plants affected by corrosive sulfur dioxide and hydrogen fluoride gases included shrivelling, discoloration, and scorched leaves. Branches and twigs were covered with grayish deposits of fertilizer dusts and other particulates. Defoliation was common. The effect on sweet potato was even more devasting; on the average, a field was completely destroyed within three days. Plant growth of varied species was stunted in several cases. The magnitude of destruction was less near the source of pollution and more intense further away, corresponding to the dispersal of pollutants.
Source: 1

#1713
Sugi, Y., A. Masuda, A. Murata, and H. Yamamoto. "Kankyo osen no shokubutsu eikyo - Omuta-shi ni okeru chakusei shokubutsu no bunpu." (Effects of environment pollution on plants: Distribution of epiphytes in Omuta City). Nippon Koshu Eisei Zasshi (Japan J. Public Health), 21(10):415 (Oct 1974).

The species and their coverage of epiphytes on cherry trees, camphor trees, and Irex rotunda were investigated in Omuta City, and the results were transferred to a vegetation map. When the vegetation map was compared to the distribution curves of dust fall in the city, a similar trend was found. A direct relationship between the distribution of epiphytes and the amount of dust fall was not verified; however, an indirect relationship was obtained. The existing method of evaluating air pollution is based on the number of species of epiphytes, and a more sensitive evaluation of environment can be obtained when the type of epiphyte species data can be combined with the amount of plant growh observed.
Source: 1

#1245

Sugiura, K. "Jidosha ni yoru kankyo osen sono 2. Taiya to shado waki dojo-chu no jukinzoku bunseki." (Environmental pollution by automobiles, II. Analysis of heavy metals in tires and soils along the roads). Presented at the Preparatory Meeting of the Society for General Research on Environmental Science, Lecture Meeting, 1st, Tokyo, Japan. 140-141 (June 6-8, 1975).

Soil samples were collected in the neighborhood of Koshu Road, Fuji Subaru Line, Kawagoe Road, National Road No. 16, and Prefectural Road Kawagoe-Sakato-Keroyama. Several sites were selected at specified distances from the road on a line perpendicular to the road, and samples were collected. The soil samples were dried and analyzed by atomic absorption spectroscopy. The zinc content was very high, as high as 2000 ppm at a point 10 m from Kawagoe Road at Sunashinden 129, Kawagoe City. The content decreased with increasing distance from the road, and was 1100 ppm at a point about 50 m from the road. The cadmium content was 2 ppm at a point 10 m from the road, and was 1.2 ppm at 50 m from the road. The lead content varied between 170 and 40 ppm. The same tendency was observed at a point on National Road No. 16 in Shinsayama City. Tires made by the Yokohama Rubber Co., the Toyo Rubber Co., the Dunlop Co., and the Bridgestone Co. were crushed, burned, and the ash was dissolved with concentrated nitric acid and concentrated perchloric acid. The heavy metal content was then determined by atomic absorption spectroscopy. The Cd content of the tire treads was 4.07-37.60 ppm. The zinc content was 7300-13,000 ppm. Pollution of roadside soils by zinc, lead and cadmium is attributable to automobile tires.
Source: 1

#1714

Sugiyama, K. "Kato shokubutsu tokuni chii-rui no taiki osen shihyosei no kento to sono riyo." (Examination and utilization of the susceptibility of lower plants, especially lichens as indices of air pollution). Shizuoka Univ., (Japan), Dept. of Biology, 16 p. (March 1974).

Lichens were collected and identified as to their susceptibility to air pollution damage in order to choose suitable plant indicators. Urban graveyards have abundant lichens on the tombstones and most urban graveyards are distributed with a density appropriate to the population of the area. Eighteen genera with 34 species of lichens were collected and identified. The geographical distribution of these lichens was compared to the geographical distribution of sulfur dioxide and a species specific relationship was found. Parmelia tinctorum was the most appropriate index of pollution because of its easy identification, broad distribution, and moderate susceptibility. Geographical distributions of P. tinctorum and air quality measurements of SO2 were compared in nine cities. The lichen disappeared in the center of the cities and its growth was poor in areas where SO2 concentrations were more than 0.5-1.0 mg/day/100 sq. cm (20-40 ppb).
Source: 1

#239
Suketa, Y., A. Endo, and T. Yamamoto. "Kichu fukkabutsu no kankyo nodo to nosakubtusu e no eikyo." (Effect to agricultural crops by ambient fluorides). Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, Tokyo, Japan. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):159 (1970).

The relationship between the fluoride concentration in the atmosphere and the distance from the source was examined. The atmosphere at polluted area A, 0.5 km from the emission source, contained an average of 10 F (counting the F of unpolluted area as one). The F in dust particles varied from 0.49 to 3.25 micrograms/cu m, and showed the highest source. One-year old orange leaves at area A showed 227.0 ppm F content, and two-year old leaves had 571. 3 ppm F. One-year old leaves had 165.7 to 203.3 ppm F at the distance of 1.0 to 3.5 km from the emission source, and two-year old leaves had 365.3 to 391. 0 ppm. The F in the air captured by alkali filter paper decreased in proportion to the distance, but the ratio did not coincide with that of F content in leaves and the distance, which seemed to signify an effect of F on metabolism. The F content and visual damage on taro potatoes was compared in area B in 1969 and 1970. Leaves with visible damage 0.5 km from the emission source contained 74.4 ppm and 60.4 ppm F, and those with no visible effect had 40.9 ppm. This contrasted with the F content in the plants in the control areas (distances of 10 km or more) which varied from 9.4 to 18.9 ppm.
Source: 1

#583
Suketa, Yasunobu and Takeo Yamamoto. "Kichu fukkabutsu no shokubutsu daisha e no eikyo." (Effect of atmospheric fluoride on plant metabolism). Kogai to Taisaku (J. Pollution Control), 7(5):427-434 (May 1971).

Leaf scorch, or foliar burn, is a common symptom of plant injury caused by atmospheric fluoride. Chlorosis is another symptom of fluoride injury. The density is atmospheric fluoride and its accumulation in a living plant, the effect of fluoride on plant metabolism, and the hereditary effect of the fluoride on plants are discussed. Studies on the relationship between the

exposure factor and foliar deposition of the fluoride, or foliar burn, was introduced briefly. The value of the exposure factor is about the same for cases of both the high concentration (890 micrograms/cu m) and low concentration (40 micrograms/cu m). It also shows a similar distribution of the fluoride deposition, in high or low concentration, if the exposure factor gives the same value. Photosynthesis is adversely affected by the atmospheric fluoride. The photosynthesis of a strawberry deteriorated by 50% when the strawberry was exposed to 48 ppb hydrofluoric acid for one hour. The effect of fluoride on the respiratory organs of plants was also reported. Soy beans exposed to 0.03 ppm HF had metoblic abnormalities. The total sugar quantity of its leaves decreased from 242-253 mg/100 g to 111-141 mg/100 g and the non-reduced sugar/reduced sugar ratio decreased from 4.6-8.7 to 0.8-1.6. For the heriditary effect of fluoride on plants,is also discussed.
Source: 1

#952
Sundaresen, B.B., C.I. Harding, F.P. May and E.R. Henrickson. "Adsorption of nitrogen oxides from waste gas." Environ. Sci. Technol., 1:151-156 (1967).

Experimental studies showed that a commercial zeolite (molecular sieve) was more efficient than silica gel in removing low concentrations of nitrogen oxides from gas streams. Further studies proved that the zeolite could effectively adsorb NO_x from waste gas streams in a nitric acid plant. Adsorbed NO_x was recovered as enriched NO_x and HNO_3 by regenerating the bed at elevated temperatures with hot air and/or steam. Tests indicate that such a system could be incorporated into an existing nitric acid plant, preventing release of significant quantitites of NO_x into the atmosphere. A patent application has been filed.
Source: 5

#1715
Sundstrom, K. R., and J. E. Hallgren. "Using lichens as physiological indicators of sulfurous pollutants." Ambio, 1973:13-21 (1973).

A test system using lichens as physiological indicators of sulfurous pollutants is described. Air quality can be screened by measuring the photosynthetic rate of lichens in an area suspected of being polluted. In incubation chambers containing isotopically 2 labelled carbon dioxide ($14CO_2$), the net photosynthesis can be estimated for hundreds of lichens from a polluted area. This incorporation of $14CO_2$ can rapidly be measured by scintillation techniques. The lichens must be taken from unpolluted areas and transplanted to polluted regions. To reduce differences local climate between the control and exposed samples, the lichens must be transplanted with their original substrate. Chemical analyses of the air must be carried parallel to the biological tests. They cannot replace the biotests because they cannot measure synergetic effects.
Source: 1

#1716

Suslova, V.V. and V.S. Nikoloyevskiy. "Vliyaniye kislykh gazov na pigmentnyy sostav yev drevesnykh i gazonykh rasteniy." (Effect of acid gases on three pigment composition of the leaves of trees and lawn plants). Uch. Zap., Perm. Gos. Univ., 256:93-132 (1971).

The chlorophyll (I) a and b, carotene (II), lutein (III), violaxanthin (IV), and neoxanthin (V) contents in the leaves of plants which were subjected during various phases of their growth and development to acid gases such as sulfur dioxide, nitrogen dioxide, fluoride, hydrogen fluoride, and phosphoric oxide in various concentrations were studied spectrophotometrically and by paper chromatography. Exposure to the gases caused nonsignificant changes in the pigment content of lawn grasses with different gas resitance. Woody plants revealed an inverse relation between the content of pigments and their gas resistance. The gas-resistant plants contained less pigment and lower Ia/Ib ratios. Differences in the relative distribution of pigments in all plants were nonsignificant. Lawn grasses decreased their pigment content during phases of growth under the influence of acid gases. Pigment system composition in lawn grasses was dependent on SO2 concentration, time of exposure, and species properties. Low concentrations of SO2 during the first day caused pigment decomposition and a decrease of the pigment content on the second day. High concentrations of SO2 stabilized the plant pigments on the first and strongly decomposed them on the second day. Individual and total pigments in nonresistant and medium-gas-resistant woody plants decreased considerably, and increased with an increase of Ia/Ib ratio in the gas-resistant plants. Dependence between the gas resistance and individual and total pigment content in the woody plants was observed. The I and II stabilities in the plants in vitro were low. Statistical calculations revealed a dependence of the xanthophylls and II-IV contents on the gas resistance.
Source: 1

#1376

Suzuki, N. A. Kurosawa and C. Wada. "Kakushu sakubutsu ni tasisuru aryusan gasu no eikyo (daiippo), yobun kyushu ni oyobosu aryusan gasu no eikyo." (Studies of the influence of sulfur dioxide on various crops (I)). Proc. Symp. Japan Soc. Air Pollut., 13th, Paper 182, p. 228 (Nov 7-9, 1972).

The effects of low concentrations sulfur dioxide on various crops were studied. Spinach, white vegetable, vitamine green, snow green, barley, and wheat were exposed to 1 ppm of sulfur dioxide for a long time. Various degrees of damages were manifested in the order of seriousness of white vegetable, vitamine green, barley, spinach, wheat and snow green. The last two green vegetables showed signs of chlorosis after 45 hrs of exposure; barley leaves began to curl and show discoloration; spinach, wheat, and snow green showed no effects at this time, but in about 100 hr. all the plants began to show abnormalities. The first three specimens showed complete chlorosis on 70% of total leaves. About 30% of the leaves on the three specimens showed damage. The exposure to SO_2 seemed to damage not so much of nutrition absorption, but the formation of roots, leaves, and stalks. The synthesis of protein was very much damaged.
Source: 1

#689

Svacha, Jaroslav. "Vliv elektrarenskych popilku na obsah prvku v nekterych polnich plodinach." (The effect of power plant fly ash on the contents of elements in some crops). TERPLAN-Statni ustav pro uzemni planovani, Ustav krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiny, Sbornik Z. Mezinarodni Konference, Prague, Czechoslovakia, p. 52-56 (Sept 1971).

Investigations concerning the effect of power plant fly ash on the elemental contents of soils and plants indicate that rye, vetch, flax, and, perhaps wheat might be used for indications of landscape deterioration. The stalks of plants studied took up only the bioelements iron and calcium in larger than normal amounts; the same was found for aluminum and silicon, elements of unknown or vague function. Highest penetration into the soil exposed to the effect of fly ash was found for iron and silicon (10%); while aluminum, sodium, calcium, and magnesium were next with 1% retention. Toxic elements such as lead and arsenic for example were found in plants growing in soils with a larger fly ash admixture or in pure fly ash.
Source: 1

#688

Swain, R. E., and W. D. Harkins. "Papers on smelter smoke; arsenic in vegetation exposed to smelter smoke." (Presented at the American Chemical Society, Meeting, New York, Dec. 1906.) J. Am. Chem. Soc., 30(6):915-928 (June 1908).

As a result of a previous investigation it was estimated that the Anaconda Plant in Montana was discharging daily from its main chimney an average of 59,270 lb of arsenic trioxide. The primary incentive for this study was the claim on the part of the farmers, residing in this area, that they were suffering abnormal losses of live-stock, which they attributed to smelter fumes. A chemical analysis of the hay and wild grasses was conducted, using an application to plant tissue of the Chittenden-Donaldson method for the destruction of animal tissue. Arsenic content in the resulting extract was estimated by applying the Marsh-Berzelius method and weighing the mirrors which resulted. Values as high as 0.0263% of arsenic trioxide were obtained from mature plants which had grown five miles from the smelter. Complaints were often made by men, working on thresher machines, that the thresher dust from grain in the smoke zone irritated the skin and the mucous membranes of the eyes and nasal passages. Arsenic content of samples of hay and the dust shaken from the hay were compared. The dust shaken from hay, averaging 87 ppm or arsenic trioxide contained an arsenic content of 978 ppm. In another sample, the dust contained 7700 ppm of arsenic trioxide, while the hay itself carried only 261 ppm. These results indicate that the arsenic was deposited on the surface of the plant and was not distributed throughout the tissue. The study concluded that the source of the arsenic found in such excessive amounts in the vegetation of the region about Anaconda was the smelter smoke emitted by the plant, and that the quantity which was given off under those smelting conditions was not likely to be reduced except by the use of a less highly arsenical ore.
Source: 1

#240
Swain, R.E., and A.B. Johnson. "Effect of sulfur dioxide on wheat development." (Presented at the American Chemical Society, Division of Biological Chemistry Meeting, 86th, Chicago, Illi., Sept. 10-15, 1935.)

The effect on growing plants of long period exposure to concentrations of sulfur dioxide which are insufficient to produce typical foliar markings was investigated. Wheat plants were grown in nutrient solutions in two cabinets under identical conditions of temperature, light intensity, humidity, and circulating air volume. They were in darkness for 8 hours and under illumination for 16 hours daily. Sulfur dioxide in carefully regulated amounts was added daily to the air stream passing through one of the two cabinets for periods of 3-6 hrs of the illumination period; quantitative determinations of the concentrations were made every 5 min by the continuous sampling method. The length and number of tillers and the weight of dry tissue per plant were estimated. In none of the six runs was there any evidence of action unfavorable to normal growth and development.
Source:]

#1244
Swaine, D. J., and R. L. Mitchell. "Trace-element distribution in soil profiles." J. Soil Sci., 11(2):347-368 (1960).

The contents of total and extractable trace elements present in Scottish soil profiles are primarily related to the geological parent material from which the soils were derived. Little or no effect within the profile attributable to pedeological factors has been observed in the total contents. The most marked effect on the contents of extractable trace elements, notably cobalt, nickel, copper, manganese, molybdenum, zinc, and lead, is their increased mobilization in conditions of restricted drainage. Very high extractable amounts occur in gleyed horizons of very poorly drained soil. No marked accumulation of trace elements has been observed in the iron pan or illuvial horizons of podzolized profiles. Higher contents of acetic-acid-extractable aluminum occur in soil with unrestricted drainage, the amounts present being of the same order as the exchangeable-calcium contents. Several tables are included showing the distribution of trace elements in Scottish soil profiles.
Source: 1

#1717
Swanson, E.S., W.W. Thomson and J. B. Mudd. "The effect of ozone on leaf cell membranes." Can. J. Botany, 51(6):1213-1219 (1973).

The effects of ozone on membrane lipids and on the electric density patterns of cell membranes in electron micrography were determined in a study of the highly ozone-susceptible Bel W-3 variety of tobacco. Some plants were exposed to 0.3 + or -0.03 ppm ozone for 2 hr between 10 and 12 am, while some plants were kept as controls. Immediately after the fumigation and 2 hr

later, samples from treated and control plants were prepared for electro microscopy and lipid analysis. Analysis of fatty acids from tobacco leaves fumigated with O_3 indicated that there was no significant difference beteen the ozone treated and the control plants in the relative amounts of fatty acids. This suggested that if the primary site of the O_3 action was unsaturated lipids in membranes, then the amounts of affected unsaturated fatty acids were too small to be detected by gas chromatography. In support of this, characteristic electron microscopic images of membranes were observed in cells of fumigated leaves. Measurements of the length and width of the chloroplasts and the determination of axial ratios indicated that the O_3 treatment resulted in shrinkage of chloroplasts in contrast, mitochondrial changes were apparently explained in terms of ozone-induced swelling.
Source: 1

#1601
Swinnerton, J. W., R. A. Lamontange, and V. J. Linnenbom. "Carbon monoxide in rainwater." Science, 172(3986):943-945 (May 28, 1971).

Results are reported for a series of measurements on carbon monoxide in rainwater collected at three different locations-- in Washington, D. C., over the Pacific Ocean, and on the island of Hawaii. The measurements show up to a 200-fold supersaturation of carbon monoxide in rainwater relative to the partial pressure of the gas in the atmosphere. The additional natural source of carbon monoxide indicated by the measurements is tentatively assigned to the region where rain is first formed in clouds. There is evidence that rain contains sufficient organic matter for photochemical reactions which could lead to production of carbon monoxide. Electric discharges within clouds may also lead to a slight dissociation of carbon monoxide. Methane concentrations measured in the same rainwater samples show that the partitioning of this gas, unlike that of carbon monoxide, is very close to a state of equilibrium.
Source: 1

#1600
Swinnerton, J. W., V. J. Linnenbom, and R. A. Lamontagne. "Distribution of carbon monoxide between the atmosphere and the ocean." Ann. N.Y. Acad. Sci., 174:96-101 (1970).

Measurements made in the Caribbean, between Washington, D. C. and Puerto Rico, and in the Chesapeake Bay show that the surface of seawater is supersaturated with carbon monoxide with respect to the partial pressure of CO in the atmosphere. The CO concentration definitely increases in daylight hours and appears to decrease with depth. The supersaturated state of the waters indicates that the ocean, rather than acting as a sink, may be the largest source of CO now known. Thus, the net transport of CO across the air-sea interface would be from the water to the atmosphere.
Source: 1

#1602
Swinnerton, J. W., V. J. Linnenbom, and R. A. Lamontagne. "The ocean: a natural source of carbon monoxide." Science, 167(3920):984-986 (February 1970).

The distribution of carbon monoxide between the atmosphere and surface waters of the ocean was investigated. Preliminary results indicated that the surface waters are supersaturated in carbon monoxide with respect to the partial pressure of the gas in the atmosphere. Two 24-hour stations were occupied at which both air and surface water samples were taken at 2-hour intervals. All samples were collected and analyzed within 1 hour of collection. The stations were located 64 km east of Barbados and 112 km east of Trinidad. Two characteristics were evident; the relatively constant concentration of CO in the atmosphere at both locations; and a marked diurnal effect with respect to concentration of CO in the surface waters. The source of the excess carbon monoxide found in the seawater is not known. The mechanism of production may be biological in nature or it may be possible that photochemical decomposition of organic matter near the surface is responsible. The supersaturation of the surface waters with respect to atmospheric partial pressures of CO indicates that the net transport of carbon monoxide across the air-sea interface should be from the water into the atmosphere. Although the absolute concentrations of dissolved CO are low on a world-wide basis, the amount of CO produced could be considerable. The amount represents about 5% of the estimated carbon monoxide produced by man, which makes the ocean by far the largest natural source of carbon monoxide known, if one assumes a world-wide production of carbon monoxide in the upper layers of the ocean similar to that found in the western Atlantic.
Source: 1

#1718
Switoniak, Teresa, Jadwiga Salmowa, and Henryk Rafalski. "Biologiczna jakose bialek zbox pochodzacych z dwuch stref roznego oddzialywania obiektow przemyslowych." (Biological quality of proteins of corn from two areas of different exposure to pollution by industrial plants). Rocz. Pzh., 24(1):73-79 (1973).

The digestibility and maximum biological quality of proteins of grain growing in areas exposed to air pollution from two different industrial plants was studied. The grain studied included maize, wheat, and rye from areas near a nitrogen fertilizer plant and from areas around an exhausted sulfur mine. The value of the grain was assesses on rats. The total content of total nitrogen and protein-nitrogen was higher in the wheat and rye from the sulfur mine area. No differences in the digestibility and maximum biological quality of proteins from these areas were observed. Rye protein had the highest biological quality and growth efficiency independently of the area where it had grown. The consumption of these crops had no effect on the chemical composition of rat bodies and survival during 40 days of observation.
Source: 1

#1719
Syratt, W.J. and P.J. Wanstall. "The effect of sulphur dioxide on epiphytic bryophytes." Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, p.79-85 (April 22-27, 1968).

Ten ppm sulfur dioxide produced severe chlrophyl degradation in three species of epiphytic bryophytes: Dicranoweisia cirrata, Metzgeria furcata, and Hypnum cupressiforme var. filforme. At 5 ppm, the degradation was greater in Hypnum than either Dicranoweisia or Metzgeria. Damage to chlorophyl also showed dependence on the humidity at which SO2 was supplied: the higher the humidity, the greater the breakdown. This, and the fact that phaeophytin a is the characteristic breakdown product of chlorophyl a under acid conditions, suggest that SO2 acts as sulfurous acid. The effect of 5 ppm SO2 at 100% humidity on a respiration rate and sulfate accumulation was also studied. Dicranoweisia, in contrast to the other bryophytes, was capable of converting SO 3(2-) to SO4(2-) with relatively high efficiencies. This ability, and the markedly higher chlorophyl a content in Dicranoweisia, may enable the moss to withstand higher pollution levels.
Source: 1

#1720
Szalonek, Irena. "Die curch Fluor hervorgerufene Luftverunreinigung und die Pflanzenbeschaedigung in der Naehe eines Emaillierwerkes." (Fluorine-induced pollution and plant damage in the vicinity of a metal enameling plant). Polska Adademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, (Katowice, Poland) 117-125 (Sept 9-14, 1968).

Fluorine-induced damage observed on fruit trees and garden plants at distances of 200-500 m from a metal enameling plant initiated measurements of fluorine emission at 0.5 and 2.5-3 m above ground and of fluorine content in plant life. The tests were performed by exposing filter paper saturated with calcium hydroxide to the atmosphere for 3.5 and 10 hours and for 30 days respectively from October 1967 to February 1968. Leaves were completely destroyed on 10-year old five-m high fruit trees, and of peripheral leaf necrosis and light grey to brown spots occurred on ornamental plants and Phaseolus vulgaris. The median monthly atmospheric fluorine level in the area of greatest damage (200 m from source) was 2.649 mg F/100 sq m with a maximum of 3.029 mg F/100 sq m at 2.5 m above ground and 2.004 mg F/100 sq m at 0.5 m above ground. The pollution level at 2.5 m above ground was everywhere greater than at 0.5 m above ground. The fluorine content in leaves of bean plants at 1.5 to 2 m above ground was 285 m from the source, two to three times that of plants growing close to the ground. Fruit trees were more susceptible to damage than horticultural and crop cultures.
Source: 1

#873
Takahashi, R., Y. Suketa, and T. Yamamoto. "Kichu fukkabutsu ni yoru shokubutsu taisha e no eikyo." (Effect of atmospheric fluroide on plant metabolism). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):160 (1970).

The influence of fluoride on glycolysis phosphoric acid enzyme of gladiolus, especially on beta glycero-phosphatase action was observed. Bulbs of gladioli were cultured for three weeks in Hoagland culture solution. They were then exposed to HF of a given concentration and temperature in fumigation chambers for one, five, and 10 days. Changes in beta glycerophosphatase action, protein content, chlorophyll content, and appearance of the leaves were observed. The glycero-phosphatase actions in the gladiolus leaves exposed in HF 11.7 micrograms/cu m and 20.9 micrograms/cu m were both lower than those of the control plants. The leaves infected by 20.9 micrograms HF functioned at 55% of the normal activity. Tests also revealed that gladiolus was much more susceptible to HF damage than crocus or iris. The protein content of the leaves and bulbs of gladiolus exposed to 20.9 micrograms/cu m HF showed a 42.5% decrease. Chlorophyll content in the leaves at 11.7 micrograms/cu m was 88% of the amount in the control plants. It decreased further to 69% in 20.9 micrograms. A significant effect of atmospheric F on plant metabolism was deduced.
Source: 1

#1721
Takasaki, Tsuyoshi, Yoshihiro Matsuoka, Masaki Morikawa, and Koji Shiratori. "Yobunsekiho ni yoru taiki osen jokyo no suisoku." (The estimates of air pollution by the leaf analysis method). Chiba-ken Nogyo Shikenjo Kenkyu Hokoku (Bull. Chiba-ken. Agr. Exp. Sta.), 14:119-124 (1974).

The leaf analysis method is examined in terms of estimating the influence of air pollution on agriculture. Selection of the following conditions were found important for applying leaf analysis to the exact determination of the state of air pollution: location, the crop, time and method of collection of leaf samples, and the analysis procedure. Estimates of the range and degree of air pollution by the leaf analysis method agreed with data obtained from instruments. The assumption was made that the volume of air-polluting elements accumulated in leaves was the total of air pollution during the leaf life. The relation between growth suppression and the composition of air pollutants in leaves is expected to pave the way for quantitative determination of the damage by air pollution upon crops.
Source: 1

#1855
Tallis, J.H. Lichens and atmospheric pollution." Advan. Sci., 21(91):250-252 (Sept 1964).

The sensitivity of foliose and fruticose lichens to sulfur dioxide, and their absence in industrial areas of England and Sweden, suggest that the distribution of lichens might be used to determine the limits within which atmospheric pollution is operating. In south Lancashire, grassland yield and persistence have been markedly affected by 0.1 ppm SO2. Lichen growth here is very scanty. The critical level for growth of many foliose lichens appears to be 0.05-0.08 ppm SO2.
Source: 1

#241

Tanaka, H., T. Takanashi, and M. Yatazawa. "Aryusan gasu ni yoru shokubutsu higai no jikkenteki kenkyu (daiyonpo)." (Experimental studies on SO_2 injuries in higher plants (Part 4). (Proceedings of the Japan. Society of Air Pollution, Annual Meeting, 11th, Tokyo, Japan, 1970.) Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):152 (1970).

The effect of sulfur dioxide on amiacid metabolism was examined. Wheat seedlings one month old (20 cm) were exposed to 0.5 ppm SO2 at 22 C, and 40% humidity for four days, only during the day. A Beckman 120B amiacid analyzer revealed only slight effects, but it was conjectured that the plant had some separate amino acid in its body prior to the test, and that the effect of SO_2 was relatively low. A similar wheat seedling was placed in a closed glass container and was exposed to 300 ppm carbon dioxide (14) and 100 ppm SO_2 for 30 min under 4000 lux. The first paper chromatography of 80% ethanol solubles from the leaves revealed that the Ala. value had increased but sir. had decreased in half. The second paper chromatography revealed that in both test and control plants, four kinds of material in amino acid had taken in C(14), and two of the four were Ser. Ala. The total C(14) taken in by the test material under SO_2 exposure showed a noted decrease. The experiment proved that exposure of a plant to a high concentration of SO_2 produced hydroxysulfonate in metabolism and impaired its glycol acid function.
Source: 1

#690

Tanaka, Hirofumi, Toshiharu Takanashi, and Michihiko Yatazawa. "Experimental studies on sulfur dioxide injuries in higher plants." Water, Air, Soil Pollut., 1(2):205-211 (April 1972).

Reversible decrease in carbon dioxide fixation has been reported in rice plants exposed to low concentrations of sulfur dioxide. Alpha hydroxy sulfonate is thought to form in leaves by an addition-reaction between plant aldehyde and SO2, and to inhibit the process of the photosynthesis. Radiochemical experiments were conducted to examine the occurrence of glyoxylate bisulfite alpha hydroxy sulfonate forms of glyoxylic acid found in rice plant leaves exposed to radioactive sulfur dioxide. In plants exposed to SO2, sufficient amounts of glyoxylate bisulfite (10 to the minus 9th M/gram of fresh leaves) could be formed and thereby inhibit the progress of the path from glicolic to glyoxylic acid. The results strongly suggest that the formation of sulfite additives of aldehyde in plants exposed to SO2 and its inhibitory effect would assume a mechanism which accounts for the decrease in photosynthesis.
Source: 1

#1722

Tanaka, Hirofumi, Toshiharu Takanashi, and Michihiko Yatazawa. "Experimental studies on SO2 injuries in higher plants. III. Inhibitory effect of sulfite ion on 14CO2 fixation." Water, Air, Soil Pollut., 3(1):11-16 (March 1974).

Photosynthesis decreases reversibly in plants exposed to sulfur dioxide. Photosynthesis recovers when the exposure to SO2 is discontinued. Inactivation of a photosynthetic enzyme, ribulose-1, 5-diphosphate carboxylase, by sulfonation of its sulfhydral groups was investigated as a cause of the reversible reduction of photosynthesis. The relationship between the sulfite ion concentration in the reaction mixture and carbon (14) dioxide fixation catalyzed by the enzyme which was prepared from alfalfa leaves was explored using radioactive sodium bicarbonate. About 50% and 85% inhibitions of $^{14}CO_2$ fixation were observed at .003 M and .03 M concentration of sulfite ion in the reaction mixture, respectively. The accumulation of .0003 M sulfite ion on the reaction site of the enzyme involved in the plants which were exposed to SO2 could considerably reduce the CO2 assimilation of the plants.
Source: 1

#1733
Taniyama, Tetsuro. "Sakumotsu no aryusan gasu shogai no jittai to sono kiko ni kansuru kenkyu." (Studies on the development of symptoms and the mechanism of injury caused by sulfur dioxide in crop plants). Mie Daigaku Hogakubu Gakujutsu Hokoku (Bull. Faculty Agric., Mie Univ.), 44:11-130 (Nov 1972).

Various crop plants were fumigated with different concentrations of sulfur dioxide in order to examine injury symptoms and mechanism in relation to SO2 concentration, air temperature, relative humidity, light intensity, and growth stage of the plant. Relative resistance of the plants to SO2 was observed in the following order (greatest resistance to least resistance) for the vegatative stage: paddy rice, barley, tobacco plant, orchard grass, and alsike clover; for the reproductive stage the order was paddy rice, barley, and tabacco plant. Injury was observed on the leaves of both rape and barley even under dark conditions. Percentage of injury in dry weight was generally higher at 30 C than at 10 C in barley plants exposed to SO2. Injurious effects of SO2 on the apparent photosynthesis of both rape and barley varied with difference of air temperature during treatment with SO2, concentration of SO2, and treatment time for which the plants were exposed. The content of sulfur absorbed in rice plant leaves increased in proportion to the concentration of SO2 received although that of the kernels was not influenced by the gas, indicating that sulfur accumulated in the leaves for a long time and was not translocated to other portions.
Source: 1

#1723
Taniyama, T. "Taiki osen--tokuni iou sankabutsu ni yoru norinshokubutsu higai." (Air pollution--agriculture and forestry plants damaged by sulfur dioxides). Kogai to Nihon no Kagaku (Pollut. Jap. Sci.), 6:19-29 (Sept 1973).

The principle pollutant emitted from oil and electric power plants is sulfur dioxide. The decline in crop production caused by SO2 pollution has been increasing year by year. The effects caused by SO2 gas can be divided into visible and invisible damages. Invisible damages affect photosynthesis and respiration.
Source: 1

#874
Taniyama, Tetsuro and Hiroki Arikado. "Sakumotsu no gasu shogai ni kansuru kenkyu. 1. Su-shu sakumotsu no aryusan gasu nodo to yomen hakai teido tono kankei." (Studies on the mechanism of toxic gas injury to crop plants. 1. The relationship of sulfur dioxide concentration to the extent of leaf injury in several crops). Nippon Sakumotsu Gakkai Kiji (Proc. Crop Sci. Soc. Japan), 37:366-371 (1968).

Paddy rice, barley, tobacco, orchard grass, and alsike clover was treated for two hrs/day for seven days with sulfur dioxide concentrations of 1, 5, 10, 15, and 20 ppm. Treatment was carried out in an exposure chamber at 25 C, 20 klux light intensity, and under 76-90% humidity variation. The experiment did not demonstrate any correlation between percentage of and injury and increase SO2 concentration, nor established whether the percentage of leaf injury is related to temperature and light intensity. Injury rates at the vegetative stage decreased in the following order: alsike clover, orchard grass, barley, tobacco; in the flowering stage, the order was tobacco, barley, rice. Leaves which had just completed flowering were found to have a high gas interchangeability. Therefore, the process of SO2 injury centers around center active leaves and upward and downward leaves in accordance with the absorption process of SO2 in terms of the gas interchangeability of the leaves. With increases in SO2 concentrations or treatment time, injury progresses from the cell, depending on differences in osmotic pressure.
Source: 1

#361
Taniyama, T., and H. Arikado. "Sakumotsu no gasu shogai ni kansuru kenkyu. Dainiho: Hikari no yumu to natane oyobi hadakamugi no SO_2 gasu shogai to no kankei." (Studies on the mechanism of injurious effects of toxic gases on crop plants. II. Relation between injurious effects of sulfur dioxide and illumination in barley and rape). Text in Japanese. Nippon Sakumotsu Gakkai Kiji (Proc. Sci. Soc. Japan), 38(4):608-613 (Dec. 1968).

Rape and barley were exposed to 20 ppm sulfur dioxide in the dark and under conditions of light and 20 klux intensity. Rape and barley leaf injury in the dark was proportional to length of time of exposure. For rape in the flowering state, there was no difference in the extent of injury between light and dark conditions of exposure. In the vegetative stage, however, injury was more severe in the dark than in the light. For barley, injury was always more severe under conditions of light exposure than in the dark. The leaves of both plants absorbed sulfur under both conditions, but rape absorbed more in the light than in the dark. For rape, the absorption was proportional to length of time of exposure. Extent of leaf injury was positively correlated with the sulfur content of the leaves, but there was no visible damage to rape leaves.
Source: 1

#1727
Taniyama, Tetsuro and Hiroki Arikado. "Sakumetsu no gasu shogai ni kansuru kenkyu. Dai3po: Aryusansui no yomen sanpu ni yoru súito no shokai to shogai teido ni tsuite." (Studies on the mechanism of injurious effects of toxic gases on crop plants. III On the degree of injuries and a kind of typical symptom of injuries caused by H_2SO_3 solution spray to rice plants). Nippon Sakumotsu Gakkai Kiji (Proc. Crop Sci. Soc. Japan), 38(2):222-228 (June 1969).

Two kinds of typical symptoms of injuries caused by sulfur dioxide were observed on the leaf blade and sheath of paddy rice. Countless spots of brown color and lesions of white were observed at the tip of the leaf blade, interveinal, and sometimes, marginal part of the leaf blade and sheath. To verify the suspected causative agent, rice plants were sprayed with sulfurous acid solution either in the daytime or at night. Countless spots of brown color were identified as a typical symptom of injuries by H_2SO_3 solution spray either in the daytime or at night. No lesions of white color were observed in either treatment. Destruction of chlorophyll in the leaf brought about a decrease of chlorophyll content almost in parallel with the concentration of sulfur dioxide, afflicting severe damage to the 3rd and 4th leaves (numbered downward from the uppermost of the leaf). Chlorophyll content was in proportion to total dry weight of the plant. Sulfur content of the leaf was higher in the plant sprayed with H_2SO_3 solution in the daytime than in the plant sprayed at night. A higher content of sulfur was observed in the 3rd and 4th leaves of the plant sprayed in the daytime and the 2nd and 3rd leaves of the plant sprayed at night.
Source: 1

#693
Taniyama, Tetsuro and Hiroki Arikado. "Sakumotsu no gasu shogai ni kansuru kenkyu IV. Suito no kokyusayo ni oyobosu aryusan gasu no eikyo." (Studies of the mechanism of toxic gas injury to crop plants. IV. The effects of sulfur dioxide on the respiration of rice plants). Nippon Sakumotsu Gakkai Kiji (Proc. Crop Sci. Soc. Japan), 38(4):593-597 (1969).

Experiments were conducted to determine the effect of constant exposure to sulfur dioxide on respiration of rice plants, respiration being a major factor in their dry matter production. Rice seedlings were also studied for their ability to regain respiration by first subjecting them to gas treatment for one hour and then removing the gas from the air flow. Sulfur dioxide severely affected the respiration of rice seedlings, causing maximum susceptibility corresponding to a minimum concentration of soluble sugars and free pool amino acids. Specific amino acids such as asparatate, serine, threonine, glutamate, asparagine, alanine, glycine, valine, isoeucine, leucine, histidine, and tryptophan tended to reach a minimum concentration at about the same time leaves were susceptible to ozone. Ozone exposure during the susceptible period is manifested by visible leaf flecking of the upper surface and a dramatic (up to two-fold) increase in total free pool amino acids. Most individual amino acids tended to increase except for phenylalanine, alanine, phosphoserine, phosphoethanolamine, and ethanolamine. Soluble protein is decreased but not to the same extent that the free pool amino acids increase. Because there is ample evidence that ozone enters the leaf during nonsusceptible periods as well as susceptible periods, it is postulated that ozone damage results because of the depletion of soluble reserves (carbohydrates and amino acids). Perhaps repair of damage cannot occur .
Source: 1

#360
Taniyama, T., and H. Arikado."Sakumotsu no gasu shogai ni kansuru kenkyu. Dai5ho: Suito no tansan doka sayo ni oyobosu SO_2 gasu no eikyo." (Studies on the mechanism of injurious effects of toxic gases on crop plants. V. Effects of sulfur dioxide on photosynthesis of rice plants). Text in Japanese. Nippon Sakumotsu Gakkai Kiju (Proc. Crop Sci. Soc. Japan), 38(4):598-602 (Dec. 1969).

The injurious effect of sulfur dioxide on photosynthesis and absorption of sulfur into leaves of the rice plant was examined. Both apparent and gross photosynthesis were depressed by fumigation with SO_2. Apparent photosynthesis was completely restrained 1 hr after the plant was exposed to the gas, when treated continuously at concentrations of 20 and 40 ppm. At concentrations of 6, 10, and 20 ppm, the depression of apparent photosynthesis caused by the fumigations of SO_2 for 1 hr was restored to the original state almost 2 hr after the gas was removed, but not restored at treatment concentrations of 30 and 70 ppm. When the rice plant was fumigated with SO_2 at concentrations up to 20 ppm, S content in the leaves increased remarkably, showing only slight increase as the concentration of the gas became higher. The content of S absorbed in the leaves increased in proportion to the length of fumigation period.
Source: 1

#1730
Taniyama, Tetsuro and Hiroki Arikado. "Sakumotsu no gasu shogai ni kansuru kenkyu. Dai6po: Hadakamugi oyobi natane no kogosei ni oyobosu SO2 gasu no eikyo." (Studies on the mechanism of injurious effects of toxic gases on crop plants. VI. Effects of sulfur dioxide on the photosynthesis of rape and barley). Nippon Sakumotsu Gakkai Kiji (Proc. Crop Sci. Japan), 39(1): 111-116 (March 1970).

The relationship between photosynthetic rate, air temperature, concentrations of sulfur dioxide and treatment time for which rape and barley were exposed to sulfur dioxide gas was investigated. The photosynthetic rate of rape and barley was markedly decreased by an increase in the concentration of SO2 and extention of exposure time, in the plots treated by 5 and 10 ppm SO2, respiration exceeded photosynthesis. The rate of apparent photosynthesis was decreased by about 160% 8 hr after barley was exposed to 10 ppm SO2, and about 140% 7 hr after rape was exposed to 5 ppm SO2, compared with the control. In making a comparison between the rate of decrease of the apparent photosynthesis to 0 ppm SO2 of rape and barley at 20 C, there were frequent occasions when barley was higher than rape. The rate and degree of the effect on photosynthesis of 0 ppm SO2 (control) was generally higher values at 20 C than 10 C in both plants. An injurious effect of SO2 on the apparent photosynthesis of rape and barley varied with difference of air temperature during treatment with SO2, the concentration of SO2, and treatment time for which both plants were exposed to the gas.
Source: 1

#1690

Taniyama, Tetsuro, Hiroki Arikado, and Yukihiro Iwata. "Sakubutsu no gasu shogai ni kansuru kenkyu. Daikyuho Aryusan gasu (SO2) no chokikan sesshoku ga suito no kanbutsu seisan ni oyobosu eikyo." (Studies on the mechanism of injurious effects of toxic gases on crop plants. IX. Effect of sulfur dioxide treatment for long period on dry matter production in rice plants). Nippon Sakumotsu Gakkai Kiji (Proc. Crop Sci. Soc. Japan), 40(4):455-461 (1971).

An experiment was undertaken to prove the decrease of dry matter production in rice plants caused by sulfur dioxide treatment for a long period of time. The number of tillers in rice plants decreased with an increase in the concentration of SO2, but the plant height and leaf age in rice plants did not show any significant differences. Total dry weight of leaves, stems and roots of rice plants gradually decreased with an increase in the concentration of SO2 and an extension of treatment hours for which the plants were exposed to the gas. A typical injury by SO2 was not discovered on the leaf-blade and sheath during and after treatment. Net assimilation rate and increase rate of dry matter in the rice plants were markedly decreased by SO2 treatment for a long time.
Source: 1

#1728

Taniyama, Tetsuro, Hiroki Arikado, Yukihiro Iwata, and Kazuo Sawanaka. "Sakumotsu no gasu shogai ni kansuru kenkyu: DailOppo: Aryusan gasu ni chokikan sesshoku shita suito no kogosei ankokyu ni tsuite." (Studies on the mechanism of injurious effects of toxic gases on crop plants. X. On photosynthesis and dark respiration of the rice plant fumigated with sulfur dioxide for long period). Nippon Sukumotsu Gakkai Kiji (Proc. Crop Sci. Soc. Japan), 41(2):120-125 (June 1972).

The afteraffects of sulfur dioxide treatment for long periods on photosynthesis and dark respiration in the rice plant were investigated 24 hr after treatment. The plants were exposed for 90 hr in the tillering stage to concentrations of 0, 0.271, 0.719, and 1.415 ppm and for 66 hr in the maximum tillers stage at concentrations of 0, 1.2, 4.0 and 10 ppm. There was a considerable decrease in photosynthesis 24 hr after the plant had been released from fumigation with the gas at both the tillering and maximum number of tiller stages at any concentration of the gas. Gross photosynthesis of the rice plant was gradually decreased with an increase in the concentration of the gas and the difference between the control and treated plants in apparent and gross photosynthesis was enlarged with an increase in the light intensity. The light compensation point of the rice plant moved towards a higher light intensity in accordance with the concentration of the gas. In a single leaf, the light curve of carbon assimilation in the rice plant treated with SO2 for 80 hr always showed lower values than that of the control 1, 3, and 6 days after SO2 was removed. Apparent photosynthesis decreased proportionally to increases in the SO2 concentration.
Source: 1

#1734
Taniyama, Tetsuro, Hiroki Arikado, and Hisamitsu Suzuki. "SO2 ni yoru hadakamugi no kogosei to yomen josan tono kankei narabi ni kogosei kara mita SO2 teinodo genkaichi." (Relation between photosynthesis and evaporation of rye leaf by SO2). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 5(1):154 (1970).

A newly developed carbon dioxide analyzer was used to measure the speed of photosynthesis inhibition by SO2 and the threshold value of SO2 at which photosynthesis inhibition occurs. In addition, the surface evaporation of rye leaf was measured by means of a thermopile. Three levels of air induction and four levels of light intensity were used to observe the effect of the various air induction rates of the assimilation box on the evaporation rate. There is a relationship between light intensity and evaporation rate, but the effect of light intensity increases with increasing air flow rate. After the above preliminary experiment, the speed of inhibition of photosynthesis due to SO2 was studied. Ten minutes after contact with SO2, the reduction in photosynthesis was 45% for 2 ppm, 75% for 5 ppm, and 80% for 10 ppm SO2. The apparent photosynthesis for 5 and 10 ppm sometimes showed negative values. Subsequent analysis of data showed that the reduction in surface evaporation and the apparent reduction in photosynthesis decrease proportionally with SO2 concentration.
Source: 1

#1726
Taniyama, Tetsuro and Kazuo Sawanaka. "Suito no shijitsu seisan ni oyobosu aryusan gasu (SO2) no eikyo." (The effect of sulfur dioxide on the grain production of rice plants). Proc. Symp. Japan Soc. Air Pollut., 13th, p. 227 (Nov. 7-9, 1972).

Experiments were conducted to study the effects of sulfur dioxide on the growth of rice plants. A number of flower pots with two grains each of rice were started in April 1971 and the plants were cultivated under natural conditions. Various groups of plants were given an 80-hour exposure to SO2 gas in late July and early August and from the middle to late August when the grains and flowers formed. The effects of the SO2 accumulation in the leaves were examined. The sulfur content in unpolished rice was examined. The experiments clearly showed that SO2 impaired homogenization and photosynthesis in the rice plants, and decreased the activity for the formation of roots and stalks. However, the effect of SO2 on the formation of rice grains was not clear.
Source: 1

#1729
Taniyama, T. and K. Sawanaka. "Yokkaichi chiiki no okeru nosakumotsu kogai no genkyo." (Damage of crops by environmental air pollution in Yokkaichi area). Nissaku Tokai Shibu Kenkyu Kogai (Outline Stud. Tokai Branch Jap. Soc, Agric. Crops), 63:29-31 (1972).

Crop damage from sulfur dioxide was evaluated in the Yokkaichi area in 1971 by measuring dry matter and seed production. The average concentration of SO2 per hour was 0.034 ppm from April to November 1971. There were, however, some cases of monthly hourly averages greater than 0.4 ppm. In these situations damages to major crops was largly due to sulfurous and sulfuric acid mists. The damages to major crops included brown and red spots, apical and peripheral chlorosis, yellowing of leaves, belt-like yellowing of sheath, white or black discoloration of rice plants, nonfertilization of rice plants, apical blight and chlorosis of Welsch onion, partial yellowing and general withering of pine trees in summer (and some death), watering and chlorosis of leaves of brassica species, and yellowing and spot formation on Japanese radishes. Also noted was a decrease in tiller number of rice plants (17.4 in polluted vs 19.4 in unpolluted areas). Some cases were found in which the sulfur content of SO2-damaged crops was higher than that of undamaged crops.
Source: 1

#1724
Taniyama, T. and K. Sawanaka. "Yokkaichi ni okeru suito no seiku nu tsuite." (On the growth of lowland rice plants in Yokkaichi). Nissaku Tokai Shibu Kenkyu Kogai (Outline Stud. Tokai Branch Jap. Soc. Agric. Crops), 66: 25-28 (1973).

Growth experiments were carried out on potted lowland rice plants placed near air pollution monitoring points in air polluted areas of Yokkaichi City and in relatively unpolluted areas of Tsu City. The soil conditions, fertilization, sunshine, temperature, and initial size and variety of the seedlings were identical. The period of growth was June 1 to September 29. Sulfur dioxide concentration was high in two places (30-50 ppb). There were no large differences in growth of the plants between polluted and unpolluted areas. No brown or white lesions (the specific symptom of SO2 damage) appeared even in number (it was smaller in the polluted areas). Furthermore, the leaf area and the weight of leaves, stalks, and roots was smaller on Yokkaichi than in Tsu. The number of ears and delays in time of earing showed the same tendency.
Source: 1

#694
Taniyama, Tetsuro and Kazuo Sawanaka. "Yokkaichi ni okeru taiki osen ga suito no kanbutsu ni oyobusu eikyo." (Effect of the air pollution in Yokkaichi area on the dry matter and grain production of rice plant). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):306 (Oct 1973).

The damages of agricultural produce by sulfur dioxide pollution and the resultant harvest decrease were investigated by experimental exposures. Potted rice plants were placed in groups, in Yokaichi and in a lightly polluted area of Tsu. A close relationship between the level of sulfur

dioxide and the amount of rice harvest was discovered. There were no visible damages on the plants themselves; therefore, the decrease of harvest may be regarded as the result of invisible damage of pollution. Based on this finding, the records of the past 25 years of harvests in the Yokaichi area and the Tsu area were statistically compared. With the development of the new industrial complex in Yokaichi, the amount of rice harvest began to decrease compared to the average of the Mie perfecture; the decrease is still continuing. The ratio of harvest decrease and the ratio of the cases of Yokaichi asthma (new patients) are also closely related.
Source: 1

#1732
Taniyama, Tetsuro, Toru Watanabe and Seiji Sano. "Sakubutsu no gasu shogai ni kansuru kenkyu. Dai 18 po Kakushu taiki osen busshitsu ga suito oyobi toumorokosha hikari gosei no oyobosu eikyo." (Studies of gas damages on produce; No. 18 - the effects of various air pollutants on photosynthesis on rice plants and corn). Crop Science Society of Japan Lecture, Meeting 15, 83-84 (April 3-4, 1974).

Air pollutants including ozone, sulfur dixoide, nitric oxide, nitrogen dioxide, carbon monoxide, and chlorine were used for the studies. The leaf temperature of the rice and corn plants was set at 30 C and the light intensity was 53 klux. The pollutants prevented photosynthesis of both plants, while CO promoted that of rice plants at 0.5 ppm and that of corn plants at 10 ppm. In general, rice plants were more sensitive than corn plants in terms of photosynthesis prevention. For 30 to 60 min exposure to 0.5 ppm of the pollutants, rice plants received the highest prevention rate from O3, which was followed by SO2, NO2, C12, NO, and CO. At 1.0 ppm concentrations, the order of C12 and NO reversed.
Source: 1

#1131
Tankel, Stanley B. "The importance of open space in the urban pattern." In: Cities and Space, Lowdon Wingo, Jr. (ed.). John Hopkins Press, Baltimore, pp. 57-71 (1963).

The paper has three parts: first, a brief discussion of the function of urban open space, then a longer one on the scale of open space, and finally some observations on the future of urban open space.
Source: 8

#695
Taoda, Hiroshi. "The effects of the urban environment on bryophytes and lichens." (Toshi Kankyo to sen-tai, chu-rui). Baioteku (Biotech)., 3(1):13-17, (Jan. 1972).

For more than 100 years, bryophytes and lichens have been studied as indices for the atmosphere. The dryness of the air, toxic gas, dust, and the pH index have direct influences on the growth of plants, and bryophytes and lichens are the best indicators of such conditions. In urban areas, the humidity of the air is low, the soil is impervious, nitrate and lime supplies are greater than rural areas, and there is an abundance of concrete buildings. These conditions work on special types of bryophytes, bark epiphytes, and lichens. Lichens are particularly good indicators of air pollution because they depend exclusively on rain water for nourishment and life, and water is directly absorbed from the entire body; therefore, pollutants are proportionately absorbed; the speed of growth is slower than in higher plants, and the recovery from damages take longer; they are perennial evergreens and receive the effect of pollution through the year. The growth pattern of adhesive bryophytes in Metropolitan Tokyo was investigated and a map was made. There was a clear sign that the number of species increased from the center of Tokyo toward suburban areas. The chemical reactions of sulfur dioxide on bryophytes and lichens are explained.
Source: 1

#527
Taoda, H. " Taiki Osen ga Shyokubutsu ni Ataeru Eikyō to sono Chōsa Hōhō." (Effects of air pollution on plants and methods of investigation). Japanese Journal of Ecology, 23(2):81-89 (April 1973).

Damage to plants from air pollution, especially sulphur dioxide, has been a problem since the Meiji Period. Air pollution then entered the atmosphere mainly in the form of smoke and mine dust. Some infamous examples from history are Ōkozawa, Hitachi, Ashiō, and Shininhama. Now most of the air pollution due to sulphur dioxide is caused by smelters and refineries. Some pressing areas for research into plant damage then were learning the optimum weather and seasonal conditions for absorbing smoke pollution, the concentration of pollution (the capacity for the SO_2 to absorb alkaline substances), and the amount of damage (economic) caused by the appearance of smoky areas. These questions were pursued in experiments and research in various places and gave surprising results. In some respects the study into plant damage caused by air pollution can be said to have been completed (up to the then existing level of knowledge), and can now be said to be past history (the direction and results of this work is presented in articles 1-8). Presently, the word "public hazard" brings air pollution to the minds of many, and research into plant damage has again resurfaced. However, along with changes in the form of air pollution come also changes in the forms and aims of research on the subject. Especially in connection with the problem of damage to existing plant life, one can now grasp the importance of the problem by using plant damage as an index of just how much our everyday environment has worsened with respect to pollution. What we are trying to present here are the problems concerning research and investigation into plant damage caused by air pollution and some of the solutions to these problems. What has been mentioned is readily clear, but it is a basic problem. Whatever investigative and research methods are used, these basics must always be borne in mind. The present paper is a rewritten account of a lecture given at the 19th Japan Learned Society Meeting's symposium on the problems of public hazards.
Source: 2

#1691
Tarabrin, V.P. and L.V. Chernyshova. "Narusheniye sernogo obmena v rasteniyakh pod vliyanyem zagryazneniya atmosfernogo vozdukha." (Disruption of sulfur metabolism in plants affected by air pollution). Byull. Gi. Bot. Sada, 83:96-100 (1972).

Leaves and roots from oaks, maples, lilacs, and other plants growing in an industrial area polluted with sulfur dioxide were analyzed for sulfur content to investigate the effects of SO_2 exposure on plant S metabolism. Greater than normal amounts of S were present in the leaves of exposed plants as compared to controls taken from a non-industrial area. Leaves taken from plants during a dry year showed higher accumulated S values than plants sampled during a period of heavy rainfall. The response of plants to dryness may possibly also increase SO_2 resistance.
Source: 1

#1692
Tashio, K., K. Tanabe, I. Kawasaki, S. Nakagawa, K. Namic, and K. Takemoto. "Dobutsu ni okeru shiiku kankyo no kokyuki-kei ni oyobosu eikyo (1) osen hai no keitaigakuteki bunrui ni tsuite." (Influences of breeding environment on respiratory system of animals. Part I: On the morphological classification of lung pollution). Dobutsuen Suizokukan Zasshi (J. Japan Assoc. Zool. Gard. Aquariums), 15(1):6-10 (1973).

Histo-morphological investigations of the respiratory systems in 415 cases of captive wild animals, including 73 mammals, nine reptiles, and 333 birds were made. When their lungs were classified according to the pollution level, almost no sedimentation of dust on mammalian lungs was found. Dust sedimentation did appear on alveolar cavities, the alveolar wall, parts surrounding the bronchi and vessels, connective tissues, and connective tissue layer under the pleura. On birds, dust sedimentation was frequently seen on the parts surrounding the tertiary and secondary bronchi. No dust sedimentation could be seen by low naked eye or histologically on reptilian respiratory systems. Although no chemical analyses were carried out, the dusts were identified as carbon powder by morphological observation, except for a few cases of birds in which the sediments giving interstitial reactions seemed to be silica.
Source: 1

#1693
Tate, Albert L. "Local environmental effects of a natural draft cooling tower plume." Emory Univ., Atlanta, Ga., Dept. of Biology, Thesis (M.S.), 110 p. (1973).

A field investigation of the local environmental effects of a natural draft cooling tower was conducted with emphasis on the potential for biological impact. A network of five stations was constructed at varying distances in

a geographic array around the cooling tower. Ecologically similar sites were chosen. Continuous monitoring of temperature, relative humidity, dew, and weekly accumulation of precipitation gave no indication of any effects from the cooling tower plume during the 9-month study period. Analysis of experimental data was based on the geographical array of stations and proximity to the tower and took advantage of intermittent power plant operations during the study period. Station profiles during operating and non-operating days were compared. Data from seven proximal Environmental Data Service Weather Stations for the study period and the previous 12 yr were also analyzed, but no significant impact from the cooling tower was found. The importance of water during moisture stress periods was investigated by tree ring growth analysis of exposed loblolly pines. Correlation of tree ring growth to precipitation during the period May-Aug for an 8-year comparison was 4 equals +0.96.
Source: 1

#1694
Tatekawa, H., T. Kanno, S. Saito, and H. Tachiya. "Suito ni taisuru taikigata osen no kadomiumu osen yosokuho ni tsuite." [Forecasting of cadmium in rice plant by air pollution]. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 8(3):315 (Oct. 1973).

Air pollution by cadmium, zinc, lead and copper dusts from the Aizu Refinery was investigated by measuring air quality and by checking the cadmium content in the rice plant in relation to the time of absorption of Cd from the air. The air was measured at 13 locations involving various directions and distances; samples were taken by dust jar at the end of every month and analyzed by spectropnotometry. The rice experiment was conducted at an agricultural test station. During the rice culture period of 4 mo. the northwestern and eastern sampling locations at a distance of 1.5 km each had heavy settling particles, ranging between 5 and 9 kg/sq km. The ratios of heavy metals in the settling particles were, to the west of the plant, Cd, 1; Cu, 2.1; Z, 125; and lead, 15.5. To the east, the ratios were Cd, 1; Cu, 2.1; Z, 130; and Pb, 12.1. There was a close correlation between the amount of settling Cd and Cd content in unpolished rice. The amount of Cd absorption in the rice was approximately 20% between planting of seedling and the first ear formation; 8% during the early stage of ear formation; and 72% during the ripening stage. Pollution from the refinery should be particularly controlled during the 45 days of maturity of rice plants.
Source: 1

#1695
Tatsumi, Shuzo. "Jukinzoku to jumoku." (Heavy metals and trees). Kogai to Taisaku (J. Pollution Control), 9(9):881 - 892 (Sept 1973).

Trees near streets, in parks, and in mountainous areas of Kitakyshu, Kobe and Takamatsu cities were analyzed for metal compounds. Atomic absorption spectrophotometry was used to determine lead, zinc, copper, cadmium, manganese, and iron. Lead pollution was higher in Kobe and in the Wakamatsu area of Kitakyushu than in other areas. Zinc concentrations were highest in Kobe and were lowest in Takamatsu. Copper and cadmium concentrations were higher in large cities, and iron concentrations were generally higher in large cities. Lead pollution due to automobile exhausts proceeded at the same extent regardless of city size.
Source: 1

#1132
Taylor, J. R., and A. Hasegawa. "Control of Air Pollution by Site Selection and Zoning." p. 293-306. In: E. C. Halliday (ed.). Air Pollution. World Health Organization. 442 p. (1961).

Air pollution progresses in four steps: production, emission, transfer, and perception. Land use planning in the form of zoning may be applied to each phase. To develop a comprehensive regional plan of land utilization a complete inventory of the demographic, topographic, and climatic features of the area concerned is necessary. Some applications of zoning to control air pollution are to keep emission concentrations within acceptable mass concentrations, to encourage timed emissions, and to specify raw materials and processes.
Source: 8

#876
Taylor, O. Clifton. "Agriculture and air pollution." California Air Environ., 1(6):1-3 (April-June 1970).

Air pollution damage to vegetation in California over the last two decades is conservatively estimated at $44,000,000. Most of the damage is due to the secondary pollutants produced by photochemical reactions in polluted atmospheres: nitrogen dioxide, ozone, and peroxyacetyl nitrate (PAN). With the exception of ethylene, the primary pollutants are relatively nontoxic to vegetation. Sensitive plants exposed for one hour or more may be visibly injured when nitrogen dioxide concentrations exceed 6 ppm; ozone, 5 pphm, and PAN, 10 ppb. Ozone enters through stomatal openings on leaves and attacks mature leaf tissue rich in green chlorophyll pigment. On highly sensitive plants, 'bifacial' necrotic spots extend completely through the leaf tissue. More subtle symptoms of ozone injury are bleaching of leaves, red pigmentation, chlorosis, premature abscission of leaves, and growth suppression. Severe injury from PAN on highly sensitive plant tissues is usually represented by complete collapse of tissue in a transverse band across some portion of the leaf. Less definite symptoms include growth suppression and abscission of plant parts. Ethylene from external sources can cause growth retardation, downward curvature of shoots and leaf petioles, abscission of leaves and flowers, irregular opening of flowers, and abnormal floral tissue. Experiments with synthesized toxicants have shown that injury produced by a mixture of pollutants, may be more severe than the added effect of two toxicants used separately. This synergistic effect, and the possible interaction with other environmental factors, may make a particular toxicant a greater threat in one locality than in another.
Source: 1

#1696

Taylor, O.C. "Air pollutant effects influenced by plant-environmental interaction." Preprint, 3 p. (1974).

Genetic variability is a major determinant of plant tolerance to air pollution. Differences in susceptibility between species or genera are well-known, but significant variation between individuals within a variety or cultivar has been less obvious. Tolerance and characteristics of symptoms are also dependent on the way exposure to pollutant occurs. Exposure to high concentrations of toxic pollutants usually produces symptoms quite different from those produced by long exposures to low concentrations. The susceptibility of plants was greater when they were exposed to a given dose of ozone in 1 hour than when the same dose was applied in multiple exposures. A number of external and internal factors are influential in determining the susceptibility of a specific plant to an airborne toxicant. Rapid-vigorous growth usually increases susceptibility. Plants grown in intense light are more susceptible to peroxacetyl nitrate (PAN), and low light intensity enhances susceptibility to ozone. A long dark period prior to exposure increases O3 susceptibility. Light before and after exposure to PAN is required for injury development. A long photoperiod or a long dark period (more than 24 hr) before exposure enhances O3 injury. High temperature during exposure in the field increases O3 susceptibility. High relative humidity increases susceptibility to O3 and PAN. Soil moisture deficiency reduces susceptibility to O3, PAN, and sulfur dioxide. Salinity reduces susceptibility to ozone. High nutrient concentration (nitrogen) generally increases susceptibility. Mixtures of toxicants may interact to increase or decrease plant injury.
Source: 1

#1919

Taylor, O.C., D.B. Drummond, and P.R. Miller. "Acceptable limits for air pollution dosages and vegetation effects: Peroxyacyl nitrates." Presented at the Air Pollution Control Association, Annual Meeting, 67th, Denver, Colorado. 74-228 (June 9-13, 1974).

Various plant damage studies are cited to establish acceptable limits for air pollution dosages of peroxyacyl nitrates in relation to vegetation effects. Factors other than pollutant dosage which influence damage susceptibility include: plant genetics, period and intensity of light exposure, physiological stage of leaf tissue development, and environmental factors which suppress plant growth, including temperature and relative humidity. Studies of peroxyacetyl nitrate, the least phytotoxic of the peroxyacyl nitrate series of compounds, indicate that a 2-hour exposure to approximately 10 ppb of PAN is sufficient to produce considerable glazing, bronzing, and silvering if plant and climatic conditions are favorable.
Source: 1

#584
Taylor, O. Clifton and David C. MacLean. "Nitrogen oxides and the peroxyacetyl nitrates." In: Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas, Jay S. Jacobson and A. Clyde Hill (eds.), Air Pollution Control Assoc., Pittsburgh, Pa., pp. E1-E14 (1970).

The effects of nitrogen oxides and peroxyacetyl nitrate (PAN) on vegetation are discussed. The susceptibility of some plants to nitrogen dioxide induced is shown in tabular form. Continuous exposure of pinto bean and tomato plants for 10-22 days to 0.5 ppm NO_2 suppressed growth without attendant foliar lesions. Acute foliar markings produced by high-concentration NO_2 exposures are characterized by water-soaked lesions in the upper leaf surface, followed by rapid tissue collapse. Gradually these lesions extend through the leaf and produce small necrotic patches. External factors reported to affect plant sensitivity to NO_2 include soil moisture, light, and relative humidity. No visible symptoms of leaf injury from nitricoxide have been reported. It is thought that NO may cause growth suppression without detectable leaf symptoms. Young plants are more susceptible to PAN than older plants of the same species. Peroxypropionyl nitrate (PPN) is several times more toxic than PAN, and peroxybutyl nitrate (PBN) is more toxic than PPN, but no differences in injury symptoms produced by the three compounds have been noted. PAN injury develops on three or four rapidly expanding leaves of a sensitive species. Injury appears at the apex of the youngest leaf, as a diffuse band across the intermediate-aged leaf, and at the base of the oldest leaf. Total collapse and necrosis of sensitive leaf tissue occurs when susceptible plants are exposed to high concentration. Incipient chlorosis develops and the injured area becomes flaccid.
Source: 1

#259
Tazieff. H. "Volcanism and atmospheric conditions." Proc. Int. Symp. Environ. Meas., Geneva, Switzerland. 131-132 (Oct 2-4, 1973).

Volcanoes emit solid particles, liquid particles, and gases into the atmosphere during volcanic eruptions and during continual exhalation of dormant and inactive volcanoes. Particulate matter ranges from 1000-100 million cu m for a single eruption. The amounts of matter emitted into the oceans and deposited on the oceans is greater than the amount emitted into the atmosphere. The volcanoes discharge carbon oxides, sulfur dioxide, hydrogen, hydrogen sulfide, halogens, and trace metals during dormancy.
Source: 1

#1865
Temple, P. J. "Dose-response of urban trees to sulfur dioxide." (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo., June 1970, Paper 70-145). J. Air Pollution Control Assoc., 22(4):271-274 (April 1972)

Four species of urban trees, i. e., gingko, Norway maple, pin oak, and Chinese elm, were fumigated with sulfur dioxide under controlled experimental conditions to determine the dose-response relationships. Resistance to SO_2

increased in the order: Chinese elm, Norway maple, gingko, and pin oak. Elm showed almost 100% leaf necrosis at exposures over 2 ppm for 6 hr and severe chlorosis and necrosis at 0.25 ppm for 30 days. Fifty percent leaf necrosis occurred on Norway maple at 3 ppm for 6 hr and on gingko at 4 ppm for 6 hr; both species developed moderate marginal chlorosis at 0.50 ppm for 30 days. Injury on pin oak was minor, even at 8 ppm for 8 hr, but at 0.50 ppm for 30 days, a slight overall chlorosis developed on the leaves. The relative susceptibilities of the species were equal for long and short-term exposures. Duration of exposure and concentration of the pollutant were of equal importance in producing injury on Chinese elm and probably on pin oak; on Norway maple and gingko, concentrations of SO_2 was of greater importance than duration of exposure.
Source: 1

#1920
Templin, Eugen. "Zur Populationskynamik einiger Kiefernschadinsekten in rauchgeschaedigten Bestaenden." (On the population dynamics of several pine pests in smoke-damaged forest stands). Wiss. Z. Tech. Univ. Dresden, 11(3): 631-637 (1962).

Population dynamics of bark-hatching and sprout-and-bud infesting insects were examined for smoke-damaged forest stands of Scotch pine in the vicinity of industrial polluters. The occurrence of Myelophilus piniperda L., Phaenops cyanea F., Rhyacionia buoliana Schiff., and Exoteleia dodecella L. was compared within and outside of the industrial emission areas. The death of pines in the most severely damaged forest stands exposed to fumes and smoke proceeded on a trunk-by-trunk basis, with pronounced individual specific differences in damage being observed. Sharp increases in the infestation of forests near factories by sprout-and-bud infestors were observed, while the proportion of trees infested by bark-hatchers was lower than under similar ecological conditions outside the industrial areas.
Source: 1

#1923
Tennessee Valley Authority, Muscle Shoals, Ala., Technical Library. "Effects of air pollution on lichens and bryophytes (1940-1974)." TVA Bibliography 1294, 3 p. (June 11, 1974).

References are presented of papers concerning the effects of air pollution on lichens and bryophytes. The papers were published between 1940 and 1974.
Source: 1

#1922
Tennessee Valley Authority, Muscle Shoals, Ala, Technical Library. "Effects of atmospheric fluorides on plants and animals (1950-1974)." TVA Bibliography 1061, 11p. (1974).

References are given on papers discussing the effects of fluorides on plants and animals published from 1950 to 1974.
Source: 1

#1924
Tennessee Valley Authority, Muscle Shoals, Ala., Technical Library. "Sulfur dioxide effects on plants and animals (1967-1974)." TVA Bibliography 1416, 13 p. (June 14, 1974).

References are presented for papers concerning the effects of sulfur dioxide on plants and animals which were published between 1967 and 1974.
Source: 1

#1926
Terakado, K. "Tokyo kokagaku sumoggu no shokubutsu higai ni kansuru chosa kenkyu. 2. PAN (Paokishiashiru naitoreto) shojo ni nita 'echunia no higai ni tsuite." (Investigation and studies on plant damage due to Tokyo photochemical smog. Part II: On the damage of petunia which showed the symptoms like injuries by PAN (Peroxyacetyl nitrate)). Tokyo-to Nogyo Shikenjo Kenkyu Nenpo (Annu. Rep. Tokyo Met. Agr. Exp. Sta.), 1972:2-3 (Oct 1973).

Twice in the middle of June and in early August 1972, petunia leaves were damaged by peroxacetyl nitrate in Tokyo. The leaf damage, root activity, and pH and specific conductivity of the soil were studied. Similar plants were exposed experimentally to ozone for comparison. No damage was found on other types of plants in the same greenhouse, and different types of petunias were damaged to different degrees. The damage was studied by microscopy and by gross symptoms.
Source: 1

#1925
Terakado K. and H. Fukuda. "Kankyo bakuroshitsu no kino." (On the function of the controlled-condition room where plants are exposed to several conditions of air pollution (environment simulation room)). Tokyo Metropolitan Agricultural Experiment Station, p. 24-26 (Feb. 1974).

Plants were studied for use as indices of air pollution. Index plants were studied for adaptibility to the environment and to air pollution, susceptibility to air pollution (especially to oxidants), ability to grow anywhere, and ability to change factors of the outdoor environment. Rooms were devised to hold plants during exposure tests. These would automatically irrigate the soil, give artificial rainfall and other weather conditions, automatically supply pollution, and automatically determine the air pollution.
Source: 1

#60

TerHaar, G. "Air as a source of lead in edible crops." Env. Sci. & Tech., 4(3): 226-229 (March 1970).

The effect of airborne lead on the lead concentration of the edible and nonedible portions of several important types of food crops was studied by growing crops in greenhouses supplied with filtered and ambient air, and in plots planted in long rows perpendicular to a busy highway. Of the ten crops studied - wheat, potatoes, tomatoes, sweet corn, carrots, cabbage, oats, rice, leaf lettuce, and snap beans - eight were not affected by the concentration of lead in air. In both sets of tests, inedible portions of the plants (bean leaves, corn husks, soybean husks, and oat, wheat, and rice chaff) showed a two to three-fold increase in lead concentration when grown near the road or in the greenhouse with unfiltered air. The conclusions are reached that lead occurring naturally in the soil is the main source of lead in the edible portion of the crops studied, and that airborne lead, based on the crops studied, contributes 0.5 to 1.5% of the lead content of the U.S. diet.
Source: 8

#400

Ter Haar, G. L. "The effect of lead antiknocks on the lead content of crops." J. Wash. Acad. Sci., 61(2):114-120 (1971).

The contribution of lead naturally in the soil, lead in the air, and lead content of the soil from lead deposited from the atmosphere or added artificially to the lead content of plants is examined. Plants grown in a filtered atmosphere were compared with those of a natural atmosphere. Most of the edible portions of the plant showed no effect from the increasing lead content in the air. Crops grown along a busy highway were analyzed. Edible portions of most compact crops, except soybeans and snap beans, showed no correlation between lead concentration and distance from road. The inedible parts contained two to three times higher lead concentrations when grown near the road. The leafy portions of plants near busy highways contained higher concentrations of lead. An increase of lead content in the soil did not change the concentration in the plant. Rain was not a significant source of lead. Seasonal variations and stresses on the plant were studies for correlation.
Source: 1

#950

Terraglio, F. P., and R. M. Manganelli. "The influence of moisture on the adsorption of atmospheric SO_2 by soil." Int. J. Air & Water Poll., 783-791 (Nov.-Dec. 1966).

Dry acid soils do not remove sulfur dioxide from the air but less acid soils can retain significant quantities of gas. Moisture in soil increases the amount of sulfur dioxide that will be retained by soil, so all soils can be said to remove sulfur dioxide.
Source: 5

#949

Terraglio, F. P., and R. M. Manganelli. "The absorption of atmospheric sulfur dioxide by water solutions." J. Air Poll. Control Assoc., 17:403-406 (1967).

Results of a laboratory study indicate that the rate of solution of atmospheric sulfur dioxide in distilled water, over the range of atmospheric concentrations of 0.81-8.73 mg SO_2/M^3, is a function of the concentration of SO_2 in the atmosphere, with saturation being reached more rapidly at the higher concentrations. This would indicate that rain water, with constantly renewed surfaces, can be very effective in the removal of atmospheric SO_2. The pH of the exposed water samples reached values of 4.0 or less, comparable to values observed in fog and cloud water near large industrial areas. Overall solubility of sulfur dioxide in distilled water did not follow the law of partial pressure. At the atmospheric concentrations used it was found that over 98.5% of the sulfite in solution was in the form of the bisulfite ion with, the remainder present as unionized sulfurous acid. Computations using the concentration of unionized sulfurous acid in the solution showed that the solubility of this portion of dissolved sulfite did follow the law of partial pressure.
Source: 5

#692

Tesar, Vladimir. "Hospodareni ve smrkovych porostech stredniho veku zasazenych kyslicnikem siricitym." (Forestry applied to pine trees of medium age exposed to sulfur dioxide emissions). Les. Pr., 49(9): 392-397 (1970).

The increasing number of electric power plants in Czechoslovakia using coral or naphtha as fuel brings about proportionately more cases where pine forests are exposed to the ill effects of sulfur dioxide. This pollutant attacks the needles, gradually reducing their number and density, and causing the possible death of the tree. If such conditions prevail, the recommended practical approach to primarily preserve trees of medium age, since these give the best yield in timber volume and therefore represent the greatest value from an economic point of view. An inventory of the remaining trees should be made, based on a classification which divides them into three classes according to condition of needles, namely: Grade one, with a small degree of damage, grade two with a medium degree, grade three with a heavy degree of damage. The individual trees should be marked accordingly, and then grades one and two marked for cutting every third year; grade three should be cut every year. At the time of felling, the principle of selection is to remove the specimens which indicate a shorter life expectancy, and to retain the trees of stronger appearance. No scientific accessories are available for the aforementioned classifications which, therefore, have to be arrived at by observation and experience.
Source: 1

#1917
Tesar, Vladimir and Bozena Temmlova. "Baumarbsterben in mittelalten durch Schwefeldioxyd geschaedigten Fichtenbestaenden und Moeglichkeiten seiner Prognose nach dem bestabdeszustande." (Tree mortality of median-aged pine trees damaged by sulfur dioxide and possibilities of its prediction from the condition of the stands). Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 371-388 (Sept 9-14, 1968).

Forty- to 70 year old pine trees (2890 trees) growing in the dispersion area of SO2 emissions from the power plant at Trutnov in the foothills of the Krkonose Mountains at northeastern Bohemia were observed over a five-year period and characteristics such as tree diameter, crown length in relation to height of tree, and needle cover were measured. Results were statistically evaluated and compared with comparable data derived from pine tree stands growing in an unpolluted atmosphere. Trees with the smallest diameter die first and the percentage capable of survival is negligible; thus it is economic to remove such trees. Mortality is also high in trees with inadequately developed crowns regardless of age. Trees with a needle cover of less than 30% should be felled. Through such selective thinning of pollution exposed forests the economic damage incurred can be minimized.
Source: 1

#1916
Teulon, Francoise. "Utilisation des vegetaux pour detecter la pollution fluoree autour d une usine susceptible d emettre des effluents gazeus fluores." (Examination of vegetation around a nuclear plant emitting gaseous fluorides in order to detect fluorine pollution). Commissariat a l Energie Atomique (France), Rept. CEA-R-4207, 30 p. (1971).

Chemical analysis of vegetation around nuclear power plants emitting gaseous fluorides is discussed in relation to detecting fluorine pollution. The analytical method consists of a double distillation in phosphoric acid and perchloric acid followed by a spectrocolormetric analysis (alizarine-complexon-lanthanel). The analytical method allows both the efficiency of the trapping installation and the appearance of effluents at unexpected places to be checked and can also be used to determine the advisability of prohibiting the consumption of locally grown produce by humans or fodder by cattle. Research conducted to determine the relation between visible damage to certain vegetables and their fluorine contents demonstrated that such a relation appears most strongly at the leaf level chemical analysis may thus be used to confirm or reject information obtained on the basis of visual evidence.
Source: 1

#1915
Thellier, Michel, Abdelkader Ayadi, and Claude Tromeur. "Contribution a l'etude d'interactions ioniques chlorureborate et iodure-borate lors de l'absorption par la Lemna minor L." (The effect of ionic interaction of chloride-borate and of iodide- borate on their absorption by Lemna minor L.). C.R. Acad. Sci. Paris, Ser. D, 265:1687-1690 (Nov 27, 1967).

The effect of borate ions on the absorption of chloride and iodide ions by Lemna minor was studied using the radioactive tracers Cl-36 at 23 C with an ilumination of 8000 Lux, and I-131 at 25.5 C with 600 Lux. The absorbed quantities of the tracer elements were measured with a Geiger counter. The concentrations of sodium chloride solutions tested ranged from 0.055 to 1 mM, those of potassium iodide from 0.04 to 4 mM. While the presence of borate ions in the test solutions of NaCL inhibited the absorption of Cl ions by Lemna minor, only a mild inhibition or none at all was noted in the case of the absorption of I ions. Because of the difference of the cations (sodium in the case of Cl, potassium in the case of I) no direct comparison can be drawn between the absorption of the two halogens. The absorption of I by the plant is thought to proceed by a much simpler mechanism than that of Cl.
Source: 1

#242
Thomas, B., J. A. Roughan, and E. D. Watters. "Lead and cadmium content of some vegetable foodstuffs." J. Sci. Food Agr., 23(12):1493-1498 (Dec. 1972).

The main source of lead contamination of the soil is aerial deposition from motor vehicles and industrial emissions. Urban soils can contain 17 times as much lead as rural soils. Cadmium also occurs in the soil from incineration of ferrous scrap, metallurgical processes, and as a result of its presence in motor vehicle oils and tires. Lead and cadmium in brussels sprouts, apples, pears, cabbages, potatoes, onions, leeks, carrots, swedes, watercress, frozen vegetables, cucumber, celery, tomatoes, mushrooms, and dried herbs were determined by atomic absorption spectrophotometry of the organic extract of the vegetables. The lead content of the 231 samples was in the range 0.01 to 3.85 ppm, with a mean of 0.05 ppm; the range and mean of the cadmium content were 0.01 to 0.22 and 0.04 ppm, respectively.
Source: 1

#243
Thomas, M. D. "Gas damage to plants." Ann. Rev. Plant Physiol., 2:293-322 (1951).

A detailed review is given of gas damage to plants with references containing important bibliographies. Investigations on the effects on vegetation of sulfur dioxide, other sulfur-containing gases, halogens and hydrogen halides, nitrogen oxides, ammonia, mercury vapor, and carbon compounds are cited and results discussed. Phytotoxicities of the different gases seem to depend on (a) absorbability, which is related to water solubility and reactivity with the tissues: (b) acidity or alkalinity; (c) oxidation or reduction reactions; (d) hormonal properties; and (e) toxicity of the element itself. Carbon monoxide, hydrogen cyanide and hydrogen sulfide are of comparatively low toxicity. Greater toxicity is evidenced by chlorine and sulfur dioxide due to their rapid oxidizing or reducing properties. The even greater toxicity of fluorine and iodine compounds is due to their absorption and inherent toxicity as elements in themselves.
Source: 1

#878
Thomas, M. D. "The invisible injury theory of plant damage." J. Air Pollution Control Assoc., 5(4):205-208 (Feb. 1956).

A summary is presented of the present state of knowledge of sulfur dioxide, hydrogen fluoride, coal smoke, and smog in relation to invisible plant injury. The latter is defined as interference with growth, photosynthesis, respiration, reproduction, or enzymatic function, or demonstrable increase in susceptibility to disease. The evidence relating to physiological activity seems definite that invisible injury due to the reducing conditions that characterize sulfur dioxide fumigations is a second-order effect at the most. No observations have been recorded to suggest that the gas makes plants more susceptible to disease. The oxidizing conditions in smog seem to be more effective in causing invisible injury, possibly because the normal reductive processes in the leaf are less intensive than the oxidative process. Toxic fluoride ions have to be disposed of by rather slow mechanical means like translocation and volatilization and, therefore, permit some invisible injury when threshold concentrations are exceeded. Toxic organic compounds in smoke are more difficult to characterize, because their identity has not been definitely established. Presumably they represent a wide spectrum of compounds which would have to be inactivated primarily by chemical means. They might, therefore, interfere appreciably with the normal reactions in the leaf and cause some invisible injury.
Source: 1

#1597
Thomas, M.D., R.H. Hendricks and G.R. Hill. "The action of sulphur dioxide on vegetation." Proc. Natl. Air Pollution Symp., 1st, Pasadena, Calif., 142-7 (1949).

The extent of injury to the leaves of plants by sulfur dioxide is determined primarily by the amount of the gas which is absorbed through the stomata. The time-concentration relationships and the absorption-leaf destruction relationships are discussed with respect to environmental factors such as light intensity, atmospheric humidity, and time of day, and also with respect to stomatal apertures, and the carbohydrates in the leaves. The effect on yield, due to various amounts and types of leaf destruction by sulphur dioxide fumigation, is shown to be the same as that due to equivalent leaf destruction by clipping off the leaves. Sublethal dosages of sulphur dioxide may have no effect at all, or only a temporary effect on the rate of photosynthesis of alfalfa, depending on the concentration employed.
Source: 1

#696
Thomas, Moyer D., Russel H. Hendricks, and George R. Hill. "Some impurities in the air and their effects of plants." Interdepartment Committee on Air Pollution, Washington, D.C., Air Pollut. Proc. U.S. Tech. Conf., Washington, D.C., p. 41-47 (May 3-5, 1950).

Sulfur dioxide is usually given first consideration in studies of air pollution damage to vegetation since its effects are well known and because it is often present in greater amounts than other contaminants. Even when it is not directly implicated in cases of plant injury, its concentration may be a useful index to over-all contamination. The acute and chronic effects of SO2 are described, and the state of knowledge of effects of other pollutants is noted. Recent experimental studies relating to the long-held assumption that sulfuric acid aerosols are without effect on vegetation are discussed, and three types of foliar injury typical of smog injury to plants, as observed in the Los Angeles area, are considered: typical SO2 markings; smog gas markings (silver-leaf injury); and leaf spots, which occur only in fog.
Source: 1

#1869
Thomas, M. D., and G. P. Hill, Jr., "Absorption of sulphur dioxide by alfalfa and its relation to leaf injury." Plant Physiol., 10:291-307 (1935).

The amount of sulfur dioxide absorbed by the leaf tissue of alfalfa was measured in a considerable number of fumigation treatments. As a first ap-

proximation, the extent of leaf destruction is a linear function of the amount of SO2 absorbed in a given time period. The amount of leaf destruction attending a given amount of absorption increases as the rate of absorption is increased. An absorption factor, A, which depends on the activity of the leaf in taking up the gas, is discussed. If this factor is constant in a series of experiments, the absorption equation can readily be transformed into time-concentration exposure equations. Further, it is possible to calculate from the absorption equations the exposure condition for any specified amount of leaf destruction or value of A. The evidence indicates that when the rate of absorption exceeds a certain threshold value, a specified amount of injury appears in a time which is proportional to the difference between the actual rate of absorption and the threshold rate. Assuming that the lethal dosage of sulfur dioxide is added to leaf instantaneously, and that it is all absorbed by the mesophyll cells, which represent about one half of the leaf substance, the limit of tolerance to the gas of these cells is approximately 2700 ppm in dry tissue, and 540 ppm in fresh tissue.
Source: 1

#880
Thompson, C.R., E.G. Hensel, G. Kats and O.C. Taylor. "Effects of continuous exposure of naval oranges to nitrogen dioxide." California Univ., Riverside, Statewide Air Pollution Research Center, 16 p. (1970).

Navel orange trees in greenhouses were continuously exposed to 1.0, 0.5, 0.25, 0.125, and 0.625 ppm of nitrogen dioxide beginning on April 15, 1968. Fumigation at the two highest levels was discontinued after 35 days when the trees showed severe defoliation and leaf chlorosis, and high nitrogen accumulation in the leaves was found. Treatments at the three lower levels continued until the fruit was picked on Jan. 30, 1969; these longer-term, lower-term, lower-level exposures more nearly compare with actual field conditions. They trend toward an increased leaf drop, fruit drop, and yield when the data are considered separately, and the statistical validity of these three levels when considered together and compared to filtered air, suggest that at some level below 0.25 ppm, NO2 becomes toxic to these trees and causes the deleterious effects observed. At present, it seems that none or minimal economic damage is being caused by NO2; however, if atmospheric levels increased by a factor of two, some damage can be expected.
Source: 1

#1911
Thompson, C.R. and Gerrit Kats. "Antioxidants reduce grape yield reductions from photochemical smog." Calif. Agr., 24(9):12-13 (Sept 1970).

A field study was undertaken to assess the total effect of photochemical smog on grapes. Twelve plots, each consisting of four Zinfandel grapevines in a vineyard near Cucamonga, California, were covered with 12 by 12 ft plastic-covered greenhouses. The vines were 8 ft apart, thus allowing one vine in each corner of the greenhouses. Two treatments with six replications were used: one treatment received nonfiltered ambient air supplied at 80 cu m/min, while the other received activated charcoal-filtered air at

a comparable rate. The only chemical treatment of the vines during the growing seasons was a dusting with Sevin to control leafhoppers. Fourteen weeks after the experiment started, the vines receiving the filtered air were obviously much greener, while the leaves were shown to have much more chlorophyll than those receiving ambient air. When the grapes were picked and weighed, the average weight per berry was about one-fourth greater from vines in the filtered air. Sugar content was significantly higher in the grapes grown in carbon-filtered air, but acid content was roughly the same in both treatments. Vines in carbon-filtered air had produced about 25% more growth during the season. However, the most significant result was in the yield of grapes harvested in the second season. While the yield of grapes in 1968 was 13% greater in carbon-filtered air than in ambient air, yield differences in 1969 increased to 258% under the same conditions. This difference from the 1968 values was attributed to the fact that the 1968 flower buds had probably been injured during setting in the fall of 1967 while the 1969 buds had been protected in 1968. In 1969, 103 comparable grapevines were separated randomly into two groups of 50 and 53 vines each. Fifty of the vines received three sprayings each with 1.5 g active, N,N'-diphenyl-p-phenylenediamine formulated in a citrus storage wax emulsion. Where the emulsion collected and dried in heavy deposits, the leaves remained greener than the surrounding leaf tissue. Yield from untreated vines averaged 3.88 kg while the sprayed vines yielded 4.87 kg.
Source: 1

#1912

Thompson, C. Ray and Gerritt Kats. "Effects of ambient concentrations of peroxyacetyl nitrate on navel orange trees." Environ. Sci. Technol., 9(1): 35-38 (Jan 1975).

Young navel orange trees and branches of a mature tree were enclosed and exposed for two years at Riverside, Calif., to activated carbon-filtered air, carbon-filtered air plus ambient levels of peroxyacetyl nitrate (PAN), or ambient air. The growth of the young trees was reduced by the addition of synthetic PAN at levels in ambient air. Leaf drop increased. With enclosed branches, significantly less growth occurred with PAN. Trends toward reduced yields of mature fruit occurred. Short-term apparent photosynthesis was not affected by fumigating a young tree with 20-80 ppb of PAN.
Source: 1

#879

Thompson, C. Ray, Gerrit Kats, and Earl G. Hensel. "Effects of ambient levels of NO2 on naval oranges." California Univ., Riverside Statewide Air Pollution Research Center, 16 p. (1971).

Naval orange trees, enclosed in plastic-covered greenhouses, were essentially unaffected by exposure for eight months to ambient and two times ambient concentrations of nitrogen dioxide. There was no visible evidence of injury. While a numerical increase in leaf drop from selected branches was observed with the higher level of NO2, it was statistically insignificant as were differences in total leaf drop from each tree, weight of leaves dropped, and fruit yield. These observations indicate that NO2 levels in the Los Angeles Basin are probably without effect on citrus.
Source: 1

#697
Thompson, C.R., O.C. Taylor, and B.L. Richards. "Effects of air pollutants on L. A. Basin citrus." Citrograph, 55(5):165-166, 190-192 (March 1970).

Commercially producing lemon and orange trees were enclosed in plastic covered greenhouses to which filtered or ambient air was introduced. Various air treatments were applied to test for the effects of total pollutants in ambient air(fluoride, ozone, peroxyacyl nitrates, and nitrogen oxides). The photochemical smog complex reduced the rate of water use, apparent photosynthesis, and yield of fruit in trees receiving ambient air. Fluoride levels in the atmosphere were too low to cause detectable effects. Leaf drop was significantly less in lemons receiving carbon-filtered air than in those receiving ambient air. A similar trend occurred in navel oranges. Fruit drop in navel oranges was also significantly less in carbon-filtered air. Yield of mature fruit is reduced in some cases by as much as 50%.
Source: 1

#1913
Thompson, C.R., D.T. Tingey, and R.A. Reinert. "Acceptable limits for air pollution dosages and vegetation effects: Nitrogen dioxide." Presented at the Air Pollution Control Association Annual Meeting, 67th, Denver. Color., Paper 74-227 (June 9-13, 1974).

Acceptable limits of nitrogen dioxide pollution of air are investegated in terms of effects on vegetation. Plant damages include: acute responses are manifested within 24 hr after 1-2 hr exposure resulting in intercostal bifacial necrotic collapse of leaf tissue similar to the effects of sulfur dioxide; an overall waxy appearance; chronic effects which sometimes appear as an enhancement of green color followed by chlorosis and extensive leaf drop, and physiological effects resulting in altered photosynthesis, stunting, spindly growth, reduced fruit set, or reduced yield. A summary of results obtained by several investigators when plotted on a log-log scale of dosage versus plant response show a fairly good correlation considering the diverse species and experimental conditions used. Chronic injury and accompanying physiological effects initially appear on sensitive plants after 2-4 weeks exposure at 0.15-0.26 ppm NO2. Tobacco and several other crops (radish, soybean, oat, pinto bean) showed injury from 0.1 ppm NO2 plus 0.1 ppm SO2 following an exposure of four hours. Sulfur dioxide is synergistic with NO2 at 5-25 pphm and the combined effect causes injury to field-grown crops, ornamentals, and forest species in the vicinity of many urban areas.
Source: 1

#698
Thomson, William W. and Swanson, Elizabeth S. "Some effects of oxidant air pollutants (ozone and peroxyacetyl nitrate) on the ultrastructure of leaf tissues." Electron Microscopy Society of America, Ithaca, N.Y., Proc. Electron Microsc. Soc. Am., Annu. Meet., 30th, Los Angeles, Calif., 2 p. (1972).

Electron microscopic examination of leaves from bean, tobacco, and cotton plants fumigated for 0.5 to 2 hrs. with 0.3 to 1 ppm of the individual oxidants revealed that changes in the ultrastructure of the cells occurred in a sequential fashion with time following the fumigation period. Although occasional cells showed severe damage immediately after fumigation, the most obvious change was an enhanced clarity of the cell membranes. Subsequently, and often prior to the appearance of any visual symptoms of damage, changes in the chloroplasts and mitochondria are observed. In bean and cotton leaves the chloroplast stroma becomes denser and ordered arrays of granules and fibrils develop. In tobacco the ordered arrays of granules did not occur but the stroma increased in density and grana frequently had a curvilinear appearance. However, determination of chloroplast axial ratios indicated a general decrease in volume of the tobacco chloroplasts in the fumigated plants as compared to control plants. The increased density of the stroma, formation of fibrils, and general decrease in volume is probably the result of an increased dehydration of the chloroplasts brought on by permeability changes induced by the pollutants.
Source: 1

#102
Thorne, L., and G. P. Hanson. "Species differences in rates of vegetal ozone absorption." Environ. Pollut., 4(3):303-312 (October 1972).

The ability of several plant species to absorb ozone was compared. Plant shoots were placed in water, sealed in 1-liter chambers, and exposed for 4 hr to air with a constant ozone concentration. The ozone was produced by passing activated charcoal-filtered air over ultraviolet lights, and the concentration was controlled by the light intensity. Each chamber contained an inlet and an outlet for airflow and a device for measuring water uptake by the plant shoot. Ozone concentrations in outlet air were measured by bubbling the air through a neutral buffered potassium iodide solution and reading the absorbance of the released iodine on a colorimeter. Leaf surface area was measured photometrically. All plant shoots reduced ozone concentration in the fumigation chambers. The amount of reduction depended primarily on leaf surface area, leaf physiological age, leaf diffusion resistance, and plant species. Herbaceous species absorbed more ozone than woody species, and actively growing woody tissue was a much more efficient absorber than dormant tissue. There was a strong positive correlation between absorption rate and transpirational water loss. Since temperature and humidity were constant, diffusion resistance was a linear function of transpiration. This suggests that the ozone absorption potential of plants can be measured in the field with instruments that accurately measure stomatal aperture.
Source: 1, 6, 7

#585
Ting, I.P., and W.M. Dugger. "Ozone resistance in tobacco plants: a possible relationship to water balance." Atmos Environ., 5(3):147-150 (March 1971).

The tobacco varieties Bel-B (ozone resistant) and Bel-W3 (ozone sensitive) differ in general water balance. A significantly smaller root system of Bel-B results in slower rates of water transport to aerial parts; in light the water potentials are consequently lower and the leaf resistances are higher than in Bel-W3. The known relationship between soluble carbohydrate content, ozone sensitivity, and low water potential suggsts a possible basis for ozone resistance in Bel-B. These observations may be important in the selection of economically important plants.
Source: 1

#55
Tingey, D. T. "Foliar absorption of nitrogen dioxide." Master's Thesis, University of Utah. (June 1968).

Studies were conducted to determine the uptake rate of nitrogen dioxide (NO_2) by Alfalfa (Medicago sativa L., var. Ranger) and Oats (Avena sativa L, var. Park). The influence of several factors affecting the adsorption rate such as concentration of NO_2, duration of exposure, light, and darkness was evaluated. The effect of NO_2 uptake on photosynthesis, transpiration and stomatal closure was studied. The concentrations required to cause visible injury were determined. The results of the study can be summarized as follows:

1. Alfalfa and oats absorbed nitrogen dioxide from the air in excess of 150 ul NO_2/m^2 ground area/min. when exposed to 24 pphm NO_2. The initial uptake rate of NO_2 was linear over the concentration range of 0-24 pphm studied. As the length of exposure increased, uptake became non-linear in the concentration 8-24 pphm but remained linear in the range 0-8 pphm NO_2. Nitrogen dioxide uptake by alfalfa and oats decreased with time, when the plants were exposed to 16 and 24 pphm NO_2 but remained constant when the plants were exposed to 8 pphm NO_2.

2. Nitrogen dioxide absorption was measured at two light intensities in both artificial light and sunlight. In artificial light the absorption rate of NO_2 decreased when artificial light intensity was decreased, but when sunlight intensity was reduced there was no effect on NO_2 absorption.

3. Nitrogen dioxide absorption by alfalfa in the dark was approximately 40 ul $NO2/m^2$ ground area/min. when exposed to 16 pphm NO_2 with a gradual increase in uptake occurring throughout the study. Oats exposed to 16 pphm NO_2 in the dark showed an erratic uptake behavior with no trend evident.

4. The diurnal absorption rate of NO_2 by oats in sunlight was measured at 8 pphm NO_2 concentration and found to vary from 20 µl NO_2/m^2 ground area/min.in the dark to 60 µl $NO2/m^2$ ground area/min. in sunlight. Nitrogen dioxide assimilation showed a correlation to light intensity probably because light intensity influenced stomatal behavior. Carbon dioxide assimilation and transpiration were measured and exhibited similar diurnal uptake responses as NO_2 did.

5. Nitrogen dioxide absorption data, when extrapolated to the plant cover of the Salt Lake valley indicated that plants under proper conditions should be able to remove a significant portion of the NO_2 from the valley air.

6. Concentrations required to cause visible damage were determined in both light and dark NO_2 fumigations. Alfalfa was damaged by NO_2 when fumigated with 200 pphm NO_2 in the dark and 400 pphm NO_2 in the light. Oats required 600 pphm NO_2 in the light and 800 pphm NO_2 in the dark to cause visible injury.

7. When oats and alfalfa were exposed to 8, 16 and 24 pphm NO_2 for 4 hours there was no reduction in photosynthetic rate or transpiration. These same concentrations of NO_2 did not induce stomatal closure.
Source: 1

#700
Tingey, D.T., W.H. Heck, and R. A. Reinert. "Effect of low concentrations of ozone and sulfur dioxide on foliage, growth and yield of radish." J. Amer. Soc. Hort. Sci., 96(3):369-371 (May 1971).

The Cherry Belle radish was exposed to five pphm ozone and/or five pphm sulfur dioxide for 40 hr per week for five weeks and compared with controls grown in charcoal filtered air. Ozone and/or sulfur dioxide significantly reduced the plant fresh weight, leaf fresh weight, root fresh and dry weight, and root length and width. The effects of the combination of the two gases were additive except for plant fresh weight, root length, and root fresh and dry weights where the effects were significantly less than additive. Low concentrations of ozone and sulfur dioxide can be significant factors in the growth and yield of radishes.
Source: 1

#1909
Tingey, David T., Roger C. Fites, and Carlos Wickliff. "Foliar sensitivity of soybeans to ozone as related to several leaf parameters." Environmental Protection Agency, Research Triangle Park, N.C., Div. of Ecological Research and North Carolina State Univ., Raleigh, Botany Dept., 21 p. (1972).

The development of the first trifoliate leaf of soybean was followed to determine the relationship between foliar sensitivity to ozone and leaf growth, stomatal resistance, and selected soluble metabolities. Soybean was grown in washed gravel and Jiffy mix (2:1 by volume) in 225 cu cm cups. The plants were grown in a controlled environment room having a 24-hour diurnal cycle consisting of 12-hour photoperiod

at a light intensity of 36,000 luces and a dark period interupted by 3 he of incandescent light at 5500 luces. Day temperature was 28 C and night temperature was 21 C. Relative humidities were about 60 and 80% for day and night, respectively. Plants were watered twice daily. Four plants from each of the eight developmental stages were placed in an exposure chamber covered with clear Teflon located in the controlled environment room. They were then exposed in a dynamic system, for 2 hours to clean air contaminated with 980 micrograms/cu m (50 pphm) ozone. Two days later the amount of ozone-induced leaf injury was visually estimated in 5% increments (zero to 100% scale) as the percentage of the upper leaf surface showing chlorosis, necrosis, or both. Relative stomatal resistance was determined at each harvest, with a ventilated diffusion porometer. Relative stomatal resistance to gas exchange was low during the early stages of leaf growth, but increased rapidly about 25 days after seeding; because gas exchange decreased as the leaf aged. Foliar injury increased rapidly as the young leaf expanded, reaching a maximum between 11 and 16 days after seeding. Maximum injury occurred before complete leaf expansion and slowly declined with leaf age. Protein, free amino acids, sucrose, and starch concentrations, and nitrate reductase levels were highest during the early stages of leaf growth and then decreased as the leaf aged. Total soluble sugars, as measured by anthrone, declined as foliar injury intensified and then increased as foliar injury decreased. Reducing sugar levels increased sith advancing leaf age. Trends in metabolite levels relative to increased foliar sensitivity to ozone were different from trends reported for other species. This indicates that metabolite pools do not play the primary role in governing ozone sensitivity.
Source: 1

#701
Tingey, D.T., R.A. Reinert, J. Dunning, and W.W. Heck. "Vegetation injury from the interaction of nitrogen dioxide and sulfur dioxide." Preprint, Air Pollution Control Office, Raleigh, N. C., Div. of Effects Research, 19 p. (1971).

Six plants were exposed for four hours to nitrogen dioxide and/or sulfur dioxide in greenhouse exposure chambers. Although concentrations of NO_2 below 20 pphm and concentrations of SO_2 below 50 pphm caused no leaf injury, injury did develop when plants were exposed to mixtures of 5 to 25 pphm of each of the two gases. Leaf injury from either NO_2 or SO_2 alone occurred as marginal and/or interveinal bifacial necrosis. Injury produced by a mixture of the two gases appeared as chlorotic and necrotic flecking on the upper surfacd of the interveinal areas of tomato, radish, oats, and tobacco. Reddish brown lesions (stipple) developed on pinto bean and soybean leaves. Lower-leaf-surface injury frequently occurred in the mixed gas fumigations with little or no upper surface injury. The concentrations of NO_2 plus SO_2 which caused plant injury were similar to those found in urban areas, and may result in yield losses to plants grown under field conditions.
Source: 1

#702
Tingey, D.T., R.A. Reinert, J.A. Dunning, and W.W. Heck. "Foliar injury responses of eleven plant species caused by ozone/sulfur dioxide interactions." Preprint, Environmental Protection Agency, Research Triangle Park, N. C., Div. of Ecological Research and Agricultural Research Service, Raleigh, N. C., Plant Science Research Div., 20 p. (1972).

Eleven plant species were exposed to ozone and/or sulfur dioxide to determine if a mixture of the two phytotoxic gases enhanced foliar injury. Tobacco, radish, and alfalfa exposed to a mixture of 5 pphm O_3 and 25 pphm SO_2 developed more injury than the additive injury of the single gases. In other species, such as cabbage, broccoli, and tomato, the foliar injury from 10 pphm O_3 and 100 pphm SO_2 was additive or less than additive. Leaf injury from the ozone/sulfur dioxide mix appeared as upper surface flecking, stipple, bifacial necrosis, and lower surface glazing and, in general, appeared similar to injuries from oxidant or O_3. The concentrations of O_3 and SO_2 which caused plant injury were similar to those found in urban areas, and may result in yield losses to plants grown under field conditions.
Source: 1

#1910
Tingey, D.T., R.A. Reinert, C.Wickliff, and W.W. Heck. "Chronic ozone and/or sulfur dioxide exposures affect the vegetative growth of soybean." Preprint, Environmental Protection Agency, Research Triangle Park, N. C., 14 p. (1972).

Soybean varieties were exposed to ozone (5, 10 pphm), sulfur dioxide (5, 20 pphm), or a mixture of the two (5 and 5 pphm) to determine their effect on growth and foliar injury. Foliar injury was noted on both cultivars in the O_3 and O_3-SO_2 treatments,with the Dare cultivar sustaining greater injury. Plant height, top, root (both fresh and dry weights), and the dry shoot-root ratios were significantly reduced by the 10 pphm O_3 treatment. Exposure to O_3-SO_2 significantly reduced top fresh weight, root fresh and dry weights, and shoot-root ratios. Treatments of 5 pphm O_3 or 5 and 20 pphm SO_2 had no significant effect on plant growth. The growth reductions due to the O_3-SO_2 treatment were greater than the additive reductions of the single gases.
Source: 1

#703
Tingey, D.T., R. A. Reinert, C. Wickliff, and W.W. Heck. "Chronic ozone or sulfur dioxide exposures, or both, affect the early vegetative growth of soybean." Can. J. Plant Sci., (Ottawa), 53(4):875-879 (Oct. 1973).

Soybeans were exposed to low concentrations of ozone or sulfur dioxide, or both, during the first 3 wk of growth. Foliar injury occurred on both cultivars in the O_3 and mixed treatments. Dare soybeans developed more foliar injury than Hood. Plant height, top and root fresh and dry weights, and the dry shoot-root ratios were significantly reduced by the 10 pphm ozone treatment. The mix of 5 pphm O_3 plus 5 pphm SO_2 significantly reduced top fresh weight, root fresh and dry weights, and short root ratios. Treatments of 5 pphm O_3 of 5 or 20 pphm SO_2 had no significant effects on plant growth. The growth reductions resulting from the O_3-SO_2 mix were greater than the additive reductions of the single gases. The lack of a significant cultivar/treatment interaction indicated that the growth of the two cultivars responded similarly to the various treatments.
Source: 1

#62
Tingey, D. and C. Standley. "Factors influencing ethylene evolution from ozone stressed plants." EPA (1975).

A wide range of plants (conifers, monocots, and dicots) exposed to ozone liberate more ethylene following exposure than controls exposed to charcoal filtered air. The elevated ethylene evolution persists for less than 24 hrs. The ethylene was collected from either detached leaves contained in 125 ml flasks or whole plants enclosed in 2.7 l polyethylene bags and measured by gas-solid chromatography. The amount and the rate of ethylene evolution was increased by either an increase in the ozone concentration of the duration of exposure. The slope parameter, b, in the equation, l n (ethylene) = a + b (ozone), can be used to rank plant species and cultivars according to their ozone sensitivity. The ozone induced evolution of ethylene was decreased by incubation in a nitrogen atmosphere and increased by incubation in the dark or at elevated temperatures.
Source: 8

#1906
Tokyo Metropolitan Environmental Protection Research Inst. (Japan). "Tokyo sumoggu seisei kijo shokubutsu higai ni kansuru chosa kenkyu no gaiyo." (The mechanism of formation of the Tokyo smog-a study on damaged plants). Text in Japanese, 52 p. (April 1973).

The intimate relationship between oxidant concentration, which is used as the photochemical smog index and the nitrogen odxide and hydrocarbon concentrations was confirmed in Tokyo. Approximately half of the hydrocarbons in the Tokyo atmosphere are methane and in the other half that contribute to the smog formation, 10% are unsaturated hydrocarbons, 50% are aromatic hydrocarbons and 40% are saturated hydrocarbons. Investigations at some 120 farms and parks revealed that crops in Tamagawa valley, Arakawa valley, Edokawa valley, and the outskirts of Tokyo and plants in all the parks were injured by smog. The resistance of plants to oxidants was tested in a glass chamber, and the results showed that crops, grasses, and flowers were generally weak in an ozone atmosphere, whereas trees were much stronger.
Source: 1

#1908
Tokyo Metropolitan Research Inst. for Environment Protection (Japan). "Asagao ni yoru kakagaku sumoggu eikyo chosa ni kansuru kenkyu hokoku no gaiyo." (The outline of reports on studies of photochemical smog effects utilizing a plant, morning glory). 18 p. (March 1974).

The experiments were conducted on two different morning glories through the cooperation of teachers and students of 77 junior high schools in Tokyo and three schools in the surrounding areas. The sample scarlet morning glories and violet morning glories were about 15 cm tall and were planted between May 23-31. Results showed that damages to the plant were observed when the oxidant dose was higher than 60 ppm/hr; the difference of outdoor oxidant effect between the two plants was little compared to that of indoor ozone exposure; there were 3% damages on scarlet morning glories on July 2 and 55% on July 5 at oxidant dose 10 ppm; most of the damaged plants had white spots and necrosis; the control plants either showed minor damage or had no damage at all.
Source: 1

#1905
Tollinger, V. "Beitrag zur grossraeumigen Diagnose der Rauchschaeden Die potentielle Gefahr einer Beschaedigung der Waldbestaende durch Immissionen und die Gefahr einer sekundaeren suk zessiven Zerstoerung der Landschaft." (Assessment of damage from pollution on large areas. The potential danger of damage to forests caused by emissions and the danger of subsequent secondary deterioration of the countryside). Polska Akademia Nauk, Zaklad, Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland. 261-275 (Sept. 9-14, 1968).

Damage to forests in the Krusne Hory caused by pollution from the industrial and mining area of Most in northwestern Bohemia was assessed, using as criteria the actual typological composition of the forest (including conifers, deciduous mixed forests, and special terrain vegetation), the remaining life of the tree stands, the slope of the terrain, and distance from the source of pollution plus wind direction. These criteria were evaluated by a point system and the sum of the points entered into 690 mapped squares (covering 25 ha each). To assess the remaining life in a square, test communities of 60 to 80 year old pines were chosen. Completely destroyed stands (with a life of 0 to 11 years) rated 4 points, considerably damaged stands (with 12 to 23 years of life) rated three, slightly damaged stands (with 24 to 59 years of life) rated two, and undamaged stands rated one point. The potential deterioration of the countryside was assessed by the degree of difficulty of reforestration or by its impossibility. An interpretation of the resulting map scores disclosed that of the 690 squares, only 20 were not potentially endangered and that denoded areas manifested the greatest damage to the country side.
Source: 1

#704

Tollinger, V. "Waldzoenosen als Bioindikator der Wirkung von Industrieexhalationen." (Sylvan biocenoses as bioindicators of industrial emissions). Text in German. TERPLAN-Statni ustav pro uzemni planovani, Ustav krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajiny, Shornik Z Mezinarodni Konference, Prague, Czechoslovakia, p. 107-110 (Sept. 1971).

A method for the bioindication of industrial emissions by the production loss of Conifera is exemplified by an industrial emission-damaged coniferous forest in Czechoslovakia. The degree of the forest damage was determined from the production loss of age group 4 trees, and expressed as a percentage of the last inventory. The isolines of the stock losses, obtained by interpolation, were drawn up on charts. The differences of the smoke-resistance and the adaptability of the different species were taken into account by studying changes in the composition of the forest regarding the individual species that have taken place for the last decade.
Source: 1

#705

Tomatsuri, M. "Suito ni oyobosu fussoka suiso no eikyo." (Effect of hydrogen fluoride on paddy rice). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(3):336-342 (Dec. 1971).

The effect of low concentrations of hydrogen fluoride on paddy rice was investigated with respect to HF toxicity and threshold value. Paddy rice was exposed to 2-5 ppm HF gas for 10-40 days. The fluorine content of the leaf blade and fluorine concentration in the air were positively correlated but there was no visible injury to the plants. Even under conditions of 40-day exposure to 5 ppb of HF gas, there was no difference between the fluorine content of the hulled rice, the weight of 100 grains, and the weight of straw of the exposed rice plants and the control plants.
Source: 1

#706

Tomiyaga, Y., T. Nozaki, T. Miyamoto, E. Ebisawa, and K. Taguchi. "Kashima chiku ni okeru funjin no jumoku e no eikyo ni tsuite--matsuba no jukinzoku ganyuryo." [Studies on heavy metals pollution of pine needles by dusts]. J. Japan. Soc. Air Pollution, 8(3):313 (Oct. 1973).

The heavy metal content in black pine needles were measured to see the effect of air pollution in the Kashima area. The samplings of needles were collected at nine locations including two control areas between Sept. and Dec. 1972; they were washed, and the cleansing water and needles were dissolved by nitric and perchloric acid and analyzed by atomic

absorption spectrophotometry. The soil specimens were dissolved by aqua regia-perchloric acid. The average content of iron in pine needles was 608 ppm, manganese, 299 ppm, zinc, 29 ppm, lead, 3.8 ppm, copper, 2.7 ppm, nickel, 1.4 ppm, chromium, 1.4 ppm, and cadmium, 0.26 ppm. The amount of Fe near an iron factory was particularly high and was 10 times over the Fe content in the needles in the control area; the amount of Mn was 1.5 times over, Zn, 3 times, and Pb, 2.5 times. There was a significant correlation between the amount of settling particles on the needles and the content in the needles. The amount absorbed from the dissolved settling dusts into pine needles seemed greater than the amount absorbed from the soil.
Source: 1

#1904

Tomson, N.M. "Soderzhaniye metallov v atmosfernoy pyli i vliyaniye ikh na zhivyye organizmy." (Content of metals in atmospheric dust and their effect on living organisms). Gigiena i Sanit., 10:11-13 (1948).

Analysis of test animal and plant tissue ash may serve as an index of atmospheric pollution by heavy elements, their normal concentration as trace elements in living organisms serving as a criterion for establishing maximum allowable concentrations. Test animals were exposed to a polluted environment for 5 months. Dust levels ranged from 0.02 to 0.05 mg/cu m and lead oxides constituted the major heavy-element pollutant. Lead content in exposed animals reached 95.5 mg/kg in bone (as compared to 12.2 mg in controls) and 23 mg in liver (compared to 3.7 mg). Exposed plant leaves contained 15 mg/kg of lead as compared to 90-300 mg/kg in leaves from unpolluted areas.
Source: 1

#1903

Toshkov, A.S., M.M. Shabanov, and N.I. Ibrishimov. "Attempts to use bees to prove impurities in the environment." Dokl. Bolg. Akad. Nauk, 27(5):699-702 (1974).

The effects of environmental pollutants on bees were studied in the area of a copper works in Pirdop and of a metallurgical work in Pernik, Bulgaria. The number of destroyed and affected bee families, the effects on herbaceous and arboreal vegetation, and the amounts of copper and zinc in pollen, honey, and bees were determined. When the copper plant emitted a large amount of pollution during a plant breakdown, 59 bee families perished completely, 69 lost 90% of their bees, 48 lost 80%, 56 lost 70%, 26 lost 60%, 25 lost 50%, and 15 were affected to a lesser extent. Bees which survived the poisoning were very weak. Pollen from bees living near the plant had high copper concentrations (788.72 gamma/g); honey had lower amounts (4.21-14.5 gamma/g). High concentrations of copper in the pollen were toxic to the bees, and were the main cause of death. Zinc concentrations in the pollen from bees near the metallurgical plant reached 711.11 gamma/g, while the quantities were appreciably lower in other regions of the country. Concentrations of zinc and copper in the honey were 10-100 times less than those in the pollen. Phosphorus content in the pollen was about four times higher than in the honey. The poisonous pollutants were transported by the bees to the hive mainly by means of the pollen. The high sensitivity of the bees to various poisons makes them useful as biological indicators of pollution.
Source: 1

#379
Townsend, A. M. "Sorption of ozone by nine shade tree species." J. Am. Soc. Hort. Sci., 99(3):206-208 (May 1974).

Signficant interspecific and intraspecific variation was demonstrated in the rate of foliar sorption of ozone at a concentration of 0.2 ppm. White oak and white birch leaves removed the largest quantities of O_3/hr on both a /g and a /sq dm basis. Red maple and white ash were the least efficient; coliseum maple, sugar maple, redvein maple, Ohio buckeye, and sweetgum were intermediate in rate of O_3 removal. Differences in ozone uptake were significant among four seed-source progenies of red maple. A group of seedlings from Pennsylvania demonstrated higher rates of sorption than progenies from Maine, Minnesota, and Alabama. Although significant, the differences among the red maple progenies were not as great as differences in O_3 uptake rate among most species. Sorption rates by white birch seedlings increased linearly with increasing O_3 concentration from 0 to 0.8 ppm. Red maple seedlings showed a linear increase in sorption rate from 0 to 0.5 ppm; from 0.5 to 0.8 ppm, O_3 uptake rate continued to increase with increases in concentration, but not linearly. During a continuous 8-hour fumigation at only 5%. Removal of O_3 by red maple foliage dropped rapidly after 6 hr of continuous exposure, and after 8 hr the rate had decreased 40%.
Source: 1, 6

#1902
Townsend, Alden M. and Leon S. Dochinger. "Relationship of seed source and developmental stage to the ozone tolerance of Acer rubrum seedlings." Atmos. Environ., 8(9):957-964 (Sept. 1974).

Significant variation in tolerance to 75 pphm ozone was expressed among red maple seedling progenies from four seed sources. Differences in seedling response occurred in extent of injury but not in type of injury. Seedlings from an Alabama source showed the least average foliar injury and least suppression of leaf growth after exposure to 03 in four stages of growth and four stages of leaf development. These Alabama seedlings also hibited the largest increase in height growth after each of the four fumigations. Foliar injury and suppression of leaf growth was greatest in Pennsylvania and Minnesota seedlings. Despite a high degree of foliar damage, the Pensylvania progeny showed significant retardation of growth in only one plant-growth stage, when seedlings were youngest. In all sources and in all plant-growth stages, the youngest (less than 25 mm in length) and oldest (fully expanded) leaves were most tolerant to 0.3. Leaves at least 90%, but not 100%, expanded were somewhat more susceptible. Leaves 25 mm or longer, but less than 90% expanded, were most susceptible to 03 injury. Seedlings in the two youngest plant-growth stages (4 and 11 cm) showed more foliar injury and height-growth suppression than those in the two oldest growth stages (24 and 32 cm). Fumigation of the Minnesota seedlings in the youngest growth stage caused an almost complete cessation of growth for 3 weeks. The stability of 03 tolerance during several plant and leaf ontogenetic stages signified strong genetic control. This will facilitate the selection of ozone-tolerant seedlings and seed sources of red maple.
Source: 1

#1885
Toyama, S., T. Odaira, and T. Sawada. "Asagao no kururupurasuto ni oyobosu ozon no eikyo." (Effects of ozone on the chloroplasts in leaves of morning glory). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 607-625 (March 1974).

Morning glories (1 m height) were placed in twin artificial meteorological rooms. Clean air was fed to one room, while ozone was fed to the other. Exposure times on the initial day was 1, 2 and 4 hr and 1,2, and 4 hr on the following day. Thus the 5th and 11th leaves, exposed to ozone for a total of 2, 4, and 8 hr, were employed as a experimental material. Among the leaves exposed to ozone for 8 hr, slight necrosis appeared in the fifth leaf and small decolorized flecks in the 11th. The most outstanding changes were observed on the chloroplasts in leaves of morning glory after exposure to 0.15 ppm ozone. Lamellar structure on the chloroplasts were destroyed in proportion to exposure time. The fifth leaf, for example, disintegrated after 8 hr exposure, thereby showing remarkable decrease in volume of chlorophyll. The number of chloroplast globules increased rapidly with increasing disintegration of lamellar structure. After 8 hr exposure plastides in the fifth leaf were almost filled with globules. Particles of phytoferritin were produced on stoma in plastides of the fifth leaf after 2 hr exposure to ozone. They showed a crystal structure of lattice configuration. Lysosomes, which fill stoma on the chloroplasts, showed remarkable decrease with increase in length of exposure to ozone.
Source: 1

#1899
Treshow, Michael. "Ozone damage to plants." Environ. Pollut., 1(2):155-161 (1970).

Ozone damage to plants is characterized principally by the appearance of minute, necrotic flecks developing on the upper surface of sensitive leaves; the lesions, often only a millimeter or two across, visibly appear first as a faint, chlorotic or necrotic fleck involving mesophyll palisade cells located in islets between the smallest veins. Close examination shows, however, that within 1 to 2 hrs of exposure to toxic ozone concentrations, a shiny oily cast appears on the upper leaf surface. The earliest visible indication of a general cellular breakdown is the pulling away of the plasmalemma from the cell wall and a collapse of the vacuole with a clumping of the cell organelles and cytoplasm towards the center of the cell. Grape stipple, weather fleck of tobacco, the response of conifers to ozone, the chloritic decline of Ponderosa pine, and injury to white pine are described. The relative sensitivity of 32 agronomic species to ozone in controlled fumigation studies are reported, as well as the response to O3 of a few woody native and ornamental species. Premature senescence and early defoliation were striking following fumigation even at concentrations producing no visible symptoms. Virtually every meteorological and edaphic factor in the environment influences the predisposition and sensitivity of plants to ozone and the concentration at which effects might be expected. Factors regulating the stomatal mechanisms, such as soil and atmospheric moisture, exert the greatest influence. Light, nutrient level, the time of year and day, and other environmental variables are discussed.
Source: 1

#363
Treshow, M. "Fluorides as air pollutants affecting plants." Ann. Rev. Phytopathol., 9:21-44 (1971).

The pathological effects of fluorides on plants are reviewed with respect to fluoride sources, symptomatology, environmental influences, host-parasite relations, injury control, and air quality standards. The major sources of fluoride emissions are producers of aluminum, ceramics, phosphate, and occasionally steel. Toxic concentrations of fluoride are largely airborne and absorbed by the leaves. Fluorides occur naturally in soils, but soil contamination may occasionally also provide an index of corresponding air contamination. Toxicity is influenced primarily by fluoride concentration, duration of exposure, and sequence and frequency of exposure, but may be modified by climate, e.g. temperature, and humidity, soil factors, synergistic effects of other pollutants, and biological factors. Visible symptoms of fluoride damage, e.g., chlorosis, necrosis, and tip burn, metabolic and cytogenetic effects, and effects on growth and production are considered. The effects of fluorides on host-parasite interaction are also discussed. Fluoride injury controls include the application of protective chemicals, the development of resistant species, and basic elimination of the pollutant. For the highest degree of control, air quality standards are best based on the atmospheric fluoride concentrations capable of injuring the most sensitive plant species.
Source: 1,2

#1900
Treshow, Michael. "Air pollution as an ecological factor." (Presented at the International Clean Air Conference, 1972). Clean Air, 6(3):41-43 (Aug. 1972).

The air environment is vital to the health and welfare of man and to the health of plants. Thousands of acres of forest watersheds in Europe and North America have been blighted by sulfur dioxide emissions from smelters and power plants. Fluorides, particularly from aluminum plants and the phosphate industry, have also been destructive to natural areas. The current threat to forests and crops alike is mainly from automobile exhausts. When acted on by ultraviolet light, the emissions react photochemically to form ozone and peroxyacetyl nitrate which are highly toxic to many plant species. In California, more the 150,000 acres of Ponderosa pine have been damaged by oxidants, while herbs that protect land from erosion and are vital to maintaining the nutrient balance of the soil may have been killed off. Desert ecosystems may also be sensitive to the pollutants emitted by hugh coal-burning power plants being built in the Southwest. If society is willing to take action and pay the price, the technology for reducing industrial emissions to harmless levels is available. The standards set and attainable are adequate to protect man and plants. However, two problems persist: control of emissions from transportation sources, and compelling the use of known control technology on a world-wide basis.
Source: 1

#1897
Treshow, Michael, Gerald Dean, and Frances M. Harner. "Stimulation of tobacco mosaic virus-induced lesions on bean by fluoride." Phytopathology. 56:756-758 (1967).

The possible effect of fluoride on the number of local lesions developing on Pinto bean leaver following inoculation with tobacco mosaic virus was studied. Plants were grown in fumigation chambers in which atmospheric fluoride concentrations ranged from 0.2 to 2.5 micrograms/cu m; foliar fluoride concentrations ranged from 20 to 637 ppm. The number of lesions increased with foliar fluoride concentrations up to 500 ppm, above which the number decreased. Since the number of lesions that developed varied among fumigations, the lesion numbers were converted to percentages of the control. Lesion numbers on plants in the unfumigated chamber served as a control, and these values represented 100%. The numbers of lesions on the leaves with fluoride concentrations of 100-200, 200-300, and 300-500 ppm were 121, 157, and 179% of the control, respectively. The corelation coefficient of 0.802 between fluoride concentrations up to 300 ppm and lesion numbers was significant at the 1% level. When lesion numbers were grouped according to leaf age, irrespective of fluoride concentration, lesions were most prevalent on the first trifoliolate leaves. The number of lesions diminished on the older leaves and on older plants. When leaves are fully developed and plants reach the four- to five-leaf stage, no lesions could be induced.
Source: 1

#1898
Treshow, M., and D. Stewart. "Ozone sensitivity of plants in natural communities." Biol. Conserv., 5(3):209-214 (July 1973).

Field fumigation studies with portable fumigation chambers conducted in grassland, oak, aspen, and conifer communities established the injury threshold of prevalent plant species to ozone. Several important species, including Bromus techtorum, Quercum gambelii, and Populus tremuloides, were injured by a single 2-hour exposure to 15 pphm O_3. Over half the perennial forbs and woody species studied were visibly injured at concentrations of 30 pphm O_3 or less. It is postulated that lower concentrations at prolonged or repeated exposure to O_3 may impair growth and affect community vigor and stability. Continued exposure of natural plant communities to O_3 is expected to initiate major shifts in the plant composition of communities.
Source: 1

#1896
Tsunoda, F., E. Aizawa, and S. Sakurai. "Fukkabutsu ni yoru taiki osen ni kansuru kenkyu - dai 11-po-osengen betsu ni mita sanmai chu no fusso ganyuryo ni tsuite." (Studies on air pollution due to fluorides, Part II: on the fluorine content of rice seen from the respective source of pollution). Presented at the Japan Society of Public Health, Annual Meeting, 32nd, Hiroshima, Japan, October 1973, Paper 560. Nippon Koshu Eisei Zasshi (Japan J. Public Health), 20(10 Special Suppl): 1 p. (October 1973).

The fluorine content of rice specimens obtained in the fields at various distances in various directions from factories which are regarded as the major source of fluorine pollution in the air was determined. The fluorine content per ppm of dried specimen were as follows: the average was 0.80 + or - 0.18; the averages of specimens in three areas from four aluminum refineries- A, B, C, and D, respectively, within 1 km, 1-2 km, and more than 3 km, were 3.96 + or - 1.85, 2.00 + or - 1.07 and 0.93 + or - 0.31; the averages of specimens obtained respectively in the field within 1 km, 1-2 km, and more than 3 km of a pottery manufacturing plant, E, were 7.31 + or - 4.87, 1.55 + or - 0.97 and 0.82 + or -0.1; the averages of specimens obtained in the field at the same distances as above from four phosphate fertilizer factories, F, G, and H were 1.72 + or - 1.13, 1.12 + or - 0.38, and 0.66 + or - 0.03, respectively; and the average contents of fluorine in rice specimens obtained in the field located 1-2 km and more than 3 km from three iron foundries, I, J and K were respectively 0.94 + or - 0.35 and 0.82 + or - 0.18. The fluorine content of rice appeared in decreasing order, at the same distance, from factories E, A, B, C, D, F, G, J, H, I, K. The rice obtained in the fields near the pottery and aluminum refineries was most polluted by fluorine. A case was found in which the rice harvested in a field within 1 km of an aluminum refinery contained more than 10 ppm of fluorine. The ratio of gaseous fluoride to water soluble fluoride particle in the air around potteries and aluminum refineries is given.
Source: 1

#1894
Tsunoda, F. and H. Kunita "Doshokubutsu-chu no fusso ni tsuite-shizen to osen." [Fluorine content of plants and animals]. Kogai to Taisaku (J. Pollution Control), 9(6):613-619 (June 1973).

The fluoride content in the air can be measured by plant indicators, either by the extent of plant damage or by the cumulative fluoride content in the plant. The latter seems to be more effective when dealing with fluorine in the air, since a considerable amount of F accumulation in the plant sometimes does not manifest itself in damage. Leaves of gladioli are often used as indicators, but experiments have shown that the leaves of wild iris and flags are just as susceptible to F in the air. The pine and cedar needles and tulip and orange leaves are also sensitive indicators. The measurements of soluble fluorine in the air were taken for the past 5 years by the lime treated filter paper method and a dust meter in seven polluted areas, and the cumulative F content in the leaves of iris in these areas were compared with iris leaves in control areas. By the characteristic translocation of F, the tips and edges of leaves had much higher F content than other parts of the same plant. Approximately 1/3 of the measurements in those parts could be considered as a pollution index. The leaves taken from the most polluted areas showed approximately 80 times over the leaves from control areas in dry weight. Even 1/3 of the actual measurements was 100 ppm in dry weight, 30 ppm in raw weight. The produce in air polluted areas has 5-10 ppm F content in polished rice and green vegetables. If the daily consumption of rice is 308 g/capita, 3.08 mg of F is taken daily into the human body.
Source: 1

#1895

Tsunoda, Fumio, Hiroko Kunida, Yoshiza Sato, Kazuo Sasaki, Yuzo Kawarada, Isao Kimura, Morio Murakami, Hifumi Shioi, and Takenori Yoshida. "Fukkabutsu ni yoru taiki osen kankyoka ni sanjikkagetsu shiiku shita ushi no bokenrei." (Case study of the dissection of a cattle raised in fluoride pollution for 30 months). Proc Symp. Japan Soc. Air Pollut., 13th, Paper 155, p. 200 (Nov 7-9, 1972).

Cattle raised for 30 months in an environment polluted by average of 1 ppb of fluoride and feed containing 40-60 ppm fluorine were slaughtered and disected. There were no visually dectectable anomalies. The blood test conducted immediately before slaughtering showed no anomaly in blood chemistry; liver and kidney functions were also regular. Histropathologically, slight irregularities were recognized in teeth and bones, but the heart, lungs, trachea, brain, liver, kidneys, spleen, glands, and other organs had no abnormalities. The fluorine content in all the organs were normal; high F content was noted in urine, plasma, bones, and teeth. The fluorine content in the skull was 4984 ppm; jaw 5069-5311; vertebrae 4826 to 5629; ribs 3900 to 5163; bones of the lower limb 5142; and teeth 2653 to 4889. The bones of the cattle were in the process of chemical fluorosis or bone fluoridation, or in the process of bone mottling, had not developed into abnormal bone formation.
Source: 1

#1893

Turenkov, N.I. and P.F. Zhigarev. "Zagryazneniye okruzhayushchey sredy otkhodami kaliynogo proizvodstva." (Contamination of the environment with potassium industry wastes). Pochvovedenie, 9:70-75 (Sept. 1972).

Soil and water samples taken near a potassium processing plant were analyzed, and the effects of gaseous emissions from that plant on the vegetation were studied. Soil samples taken from the upper 0-2 centimeter layer at 1 km distance from the plant contained up to 2.88 mg equivalent of chlorides per 100 g soil, originating from gaseous emissions. The Cl ion concentration in snow water samples taken at 2 km was more than twice the average value for other territories of the USSR. However, the negative effect of the gaseous emissions was most pronounced within a 1-kilometer-radius around the potassium manufacturing plant. The gaseous emissions had toxic and crop-reducing effects on farm plants, primarily on potatoes and apple and cherry trees; oats and couch-grass were relatively resistant to the emissions.
Source: 1

#131
Turk, A., and C. J. D'Angio. "Composition of natural fresh air." J. Air Pollution Control Assoc., 12(1):29-33 (January 1962).

Summary and Conclusions:

(1) It seems reasonable to infer that the nature and concentration of organic vapors of an atmosphere are among the prime determinants of its sensory quality of "freshness."

(2) The forest and seashore atmospheres examined each show that they are endowed with a rich variety in molecular structure and in numbers of components, in spite of very meager overall concentrations. The forest atmosphere is the richer in component variety of the two. Both are chemically characterized by the presence of aromatic ethers, and some unsaturated material.

(3) The mountain atmosphere was found to be too low in concentration of organic matter to be analyzed. This suggests that environments at elevations above timberline may give a sensory response of freshness due to a substantial lack of organic vapors. This type of "freshness" appears to differ from the sensory response experienced to atmospheres which contain measurable concentrations of organic vapors.

(4) The method of sampling and analysis described lends itself to some interesting applications as a tool in meteorological surveys.
Source: 1, 7

#707
Turner, N.C., S. Rich, and H. Tomlinson. "Stomatal conductance, fleck injury, and growth of tobacco cultivars varying in ozone tolerance." Phytopathology, 62(1):63-67 (1972).

Four tobacco cultivars that vary in ozone sensitivity were grown in the field and in two greenhouses, one with charcoal filtered air and one with unfiltered air. The plants were compared for stomatal conductance, stomatal frequency, height, oven-dry weight, leaf area, and amount of fleck injury. The total leaf conductance, measured with a ventilated diffusion porometer, of the ozone sensitive cultivars was greater than that of the ozone-tolerant cultivars; both adaxial and abaxial conductances were greater. However, the differences in the matal conductance were not sufficient to account completely for the differences in fleck damage. In ozone-free air, the two ozone-sensitive cultivars grew more than did the two ozones tolerant cultivars. The converse was true when the plants were grown in unfiltered air. The reduction of dry weight in the unfiltered air accompanied a reduction in the green leaf area caused by flecking and early senescence of damaged leaves.
Source: 1

#81
Turner, N. C., I. Rich, and R. E. Waggoner. "Removal of ozone by soil." J. Environ. Quality, 2(2):259-264 (1973).

Simultaneous measurements of vertical profiles of horizontal wind, temperature, and ozone concentration above a bare, freshly cultivated fine sandy loam were obtained on 12 occasions during a 4-day period in July when ozone concentrations ranged from 8 to 26 x 10^{11} molecules (mol) cm^{-3} = 4 ppb = 8 $\mu g\ m^{-3}$). The decrease in ozone near the soil surface clearly indicated that the soil was removing ozone from the atmosphere. The rate of ozone removal varied from 3 to 12 x 10^{11} mol cm^{-2} sec^{-1}. The flux into the soil varied with the concentration of ozone in the air, and indicated a resistance of about 2 sec cm^{-1} to ozone removal by the soil and the 2.5 cm air layer immediately above the soil. The rapid removal of ozone by soil in a ventilated chamber suggested a small resistance in the soil alone. A sample of soil containing 14% moisture had a resistance of 0.37 sec cm^{-1} to ozone removal, which was 0.23 sec cm^{-1} greater than that of activated charcoal, a strong adsorbing agent. Compaction and additional soil moisture increased the resistance to ozone removal, whereas autoclaving decreased the resistance.

Additional Index Words: resistance to ozone removal.
Source: 6, 7

#740
Turner, N.C., P.E. Waggoner and S. Rich. "Removal of ozone from the atmosphere by soil and vegetation." Nature, 250(5466):486-489 (Aug. 9, 1974).

Several measurements of the vertical profiles of horizontal wind, temperature, and ozone concentration above a bare, freshly cultivated fine sandy loam were obtained on 12 occasions during a 4-day period in July when ozone concentrations ranged from 8 to 26 times 10 to the 11th power mol/cu cm. The decrease in ozone near the soil surface clearly indicated that the soil was removing ozone from the atmosphere. The rate of ozone removal varied from 3 to 12 times 10 to the 11th power mol/sq cm sec. The flux into the soil varied with the concentration of ozone in the air and indicated a resistance of about 2 sec/cm to ozone removal by the soil and the 2.5 centimeter air layer immediately above the soil. The rapid removal of ozone by soil in a ventilated chamber suggested a small resistance in the soil alone. A sample of soil containing 14% moisture had a resistance of 0.37 sec/cm to ozone removal, which was 0.23 sec/cm greater than that of activated charcoal, a strong adsorbing agent. Compaction and additional soil moisture increased the resistance to ozone removal, whereas autoclaving decreased the resistance.
Source:2

#1892
Turrell, F. M. and F. M. Scott. "Effect of elemental sulfur dust on growth of citrus leaves, and its relation to the buffer capacity of the leaf-tissue fluid." Am. J. Botany, 38: 560-566 (July, 1951).

Trees of Marsh grapefruit, Eureka lemon, Valencia and Washington Navel orange were exposed to 325-mesh dusting sulfur weekly throughout one growing season; abscission of grapefruit and lemon leaves was observed, as well as in the reduction of their growth in length. The growth of Valencia and Washington Navel orange leaves increased. Reduced growth of sulfur-dusted leaves was correlated with small buffer capacities of the leaf-tissue fluids, and increased growth was correlated with large buffer capacities of these fluids. Although the volatility of elemental sulfur dust is low, volatility increases very rapidly with increase in temperature, and sulfur dusts or sprays may have little effect at moderate to low temperatures.
Source: 1

#1890
Turunen, J. and A. Visapaa. "Sulphur in pine needles and birch leaves. Part I. Determination of the sulphur content by X-ray fluorescence." Pap. Puu, 2:59-67 (1972).

A method is described for determination of the sulfur content of pine needles and birch leaves by means of X-ray fluorescence. A pellet weighing 1.4 g is prepared from dried and milled material, and the net intensity of the SK (alpha)I-line obtained from it is determined by application of the ratio method and an external standard. A flow counter and a pentaerythritol analyzing crystal were employed. The calibration lines were obtained by means of samples to which had been added known amounts of sulfanilic acid. The sulfur content of the basic materials was obtained from the calibration lines and checked by chemical means. The error of the method is + or 0.002% S at the level of 0.12% S for pine needles, and + or 0.003% S at the level of 0.23% S for birch leaves. One determination takes about 3 min, including perparation of the pellet. Details of the method are presented and a statistical examination is made of the results obtained.
Source: 1

#741
Tyler, G. "Heavy metal pollution and mineralization of nitrogen in forest soils." Nature,255(5511):701-702 (June 26 1975).

Decomposition of litter and soil enzymatic activity in areas near metal-processing industries are influenced by high concentrations of deposited heavy metals. There is evidence that ammonification rates are retarded by accumulated Cu and a Cu and Zn concentration of 3 times the background level will bring about a measurable disturbance of the nitrogen mineralization rate, limiting it severely. Soil samples were collected and aerobically incubated for 10 weeks, and the increase during incubation of the sum of ammonium, nitrite, and nitrate is reported. Thus less nitogen is available to plants.
Source: 2

#1889

Tzschacksch, O. "Die haeufigkeitsverteilung der individuellen SO2-Resistenz in Populationen und ihre Bedeutung fuer die Forstpflanzenzuechtung." (Frequency Distribution of Individual SO2 Resistance of Populations and their Significance for Forest Breeding). Beitr. Forstwirtsch.,6(3): 17-20 (1972).

A parameterless method is described for the estimation of sulfur dioxide resistance of forest tree populations based on observed frequency distribution of pollutant damage. Gas exposure results obtained from previous studies on cut branches of Pinus controta Douglas were used to determine the proportion of visually detectable necrotic needles on the branches of individual sources as a percentage of the entire mass of needles. Frequency distribution curves established from those values served for subsequent evaluation. The criteria obtained yielded very good information on the variation of individual variations within origins as shown by the position of the density means and the height of the maximum values of frequency. Evaluation by the frequency distribution not only allows for variation of individual resistance but also excludes the error of a variance analytical evaluation due to faulty standard distribution.
Source: 1

#1888

Ueno, E. "Mangan ni yoru kankyo osen no hyoka ni kansuru kenkyu: suginae shiken shokuju ni yoro shokubutsutai kakubu no Mn ryo." (Studies on environmental contamination by manganese - experimental planting of young Japan cedar). Shikoku Igaku Zasshi (Shikoku Acta Medica), 30(1):10-18 (Feb. 25, 1974).

Young Japanese cedars were planted in experimental nursery blocks. The first group of cedars was cultivated in the blocks in soil containing 20, 100, 200, or 400 g of manganese sulfate. The second group was exposed to a mist of 2, 10, 20, or 40 g of manganese sulfate solution by a sprinkler once a month for 6 mo. after planting. The manganese concentrations were determined in each part of the plant taken from each block every month. The manganese in the soil was also determined. In proportion to the dose, marked MN accumulation was observed in every part of the cedar except for the 20 g group. The accumulation proceeded especially in both old and fresh leaves. In the first group, the accumulation reached the highest level in June or July, 1 or 2 mo after planting, and then gradually decreased; but it was still at a considerably higher level than the control at the end of the experiment. In the second group, the Mn accumulation reached the highest level in August and kept that level during the following period. The findings suggest that the leaves of the Japanese cedar, which can easily be obtained any time and everywhere in Japan, would be a useful indicator for Mn environmental contamination, especially for airborne MN.
Source: 1

#708

Ulrich, B. "Forstduengung und Umweltschutz."(Forest fertilization and environmental protection). Alg. Forstz.,27 (9/10): 147-148 (March,1972).

The significance of fertilization in forests affected by sulfur dioxide emissions is discussed. The sulfur dioxide is washed out by precipitation in amounts proportional to the actual emissions. Investagations revealed soil sulfur inputs of 18-56 kg/ha yearly, in the form of sulfurous acid, sulfuric acid, or their salts. A close relationship between soil pH and sulfur input in pine forests was determined. Low pH values resulted in high sulfur inputs. The very high sulfur input in the soil under pine, compared to beech, is primarily due to the elevated filter effect of pine for atmospheric SO2. The water membrane covering needles, bark, and dead wood absorbs SO2 from the air following precipitation, forms sulfurous and then sulfuric acid, and is finally washed off by the next precipitation. Thus, the considerable filtration effect of pine results in serious soil acidification. Since the pH values usually lie below 3.5, many nutrients, particularly calcium and magnesium, are washed out. Young plants as well as grass and weeds are adversely affected by the high iron and maganese concentrations, while the H_2SO_4 hydrogen ions are used up by clay particles to release aluminum ions, with percolating waters of poor quality as a result. To prevent losses in production, and impairment in soil quality in pine forests, liming in doses of 2 t of CaO/h, repeated every 35-70 yrs, should be applied.
Source: 1

#1887

Umemoto, K., and K. Hozumi. "Correlation between the degree of air pollution and the distribution of calcium oxalate crystals in the gingko leaf." Microchem. J., 17(6):689-702 (December 1972).

Distribution patterns of calcium oxalate crystals in gingko leaves are compared in terms of the degree of air pollution at various tree locations. Leaf specimens were ashed on microscope slides in a low-temperature plasma incinerator energized with a high frequency current. The calcium oxalate previously present in the leaf survived in the ash in a state of perfect preservation and in the same spacial arrangement that characterized their original positioning in the tissue matrix. Leaves grown in a clean atmosphere yield small isolated crystals sparsely scattered throughout the mesophyll,while leaves from high pollution areas were characterized by clusters of larger and more irregular crystals lying along prominent veins.
Source: 1

#1886

Uno, Yoshio and Yoshiyuki Miyake. "Tabako no seiriteki hanten shogai ni kansuru denkyu (Daiyonho). Hanten shogai to echiren no seisei." (Studies on physiological tobacco leaf spot (IV). Ethylene production on physiological tobacco leaf spot). Utsunomiya Tabako Shikenjo Hokoku (Bull. Utsunomiya Tob. Exp. Stn.), 11:23-27 (Nov 1972).

Tobacco leaf ethylene production was examined in relation to leaf spot caused by ozone exposure. Ethylene production was positively correlated to the appearance of leaf injury and exhibited peak levels at 2 to 4 hrs. after ozone exposure. Ethylene production increases and correlations with ozone concentrations differed with different tobacco varieties.
Source: 1

#1605
Unsworth, M.H., P.V. Biscoe, and H.R. Pinckney. "Stomatal responses to sulphur dioxide." Nature (London), 239(5373):458-459 (Oct. 20, 1972).

The effect of 1-50 pphm sulfur dioxide on stomatal diffusive resistance of beans and maize was studied with a diffusion porometer. Variation of stomatal diffusive resistance between leaves of the same plant was related to age: the younger leaves had smaller resistances. The effect of SO2 on stomatal diffusive resistance was considerably greater on all leaves of the water-stressed plant, implying an undesirable increase in water loss.
Source: 1

#1884
Urabe, Takeyuki, Kaoru Kayama, Toru Tadamasa, Etsuho Inoue, and Shunsaku Hirayama. "Taiki osen no jumoku no oyobosu cikyo narabi ni ryokka jumoku ikusei ni kansuru kenkyu (II)." (Studies on the effect of air pollution on trees and on the growth of green trees (II)). Okayama-ken Ringyo Shikenjo Hokoku (Bull. Okayama Prefect For. Exp. Stn.)., 13:202-222 (Oct.1973).

Following the 1971 investigation of the effects of air pollution on trees, investigations were made on 20 red pines at 13 locations near Kurashiki. Meteorological data were obtained from the Kurashiki Municipal Pollution Monitoring Center and the Okayama Regional Weather Observation Station. The trees were checked in July, early September, late September, and December, and sulfur trioxide was measured monthly by lead dioxide. The sulfur contents from the needles of three red pines that were studied in 1971 were examined by the combustion quick analyzing method. Pollution levels were high between April and August, and December and March. The averages at the 13 locations ranged from 0.02 to 0.63 mg SO3/day/100 sq m. The highest pollution count was 1.06 mg. The relationship between the height of the trees and the distance from emission sources was not clear. There was no correlation between pollution and the diameter growth of trees. Several parasitic diseases were noted, and the degree of damage was much more serious than in 1971. The correlation between pine needle deterioration and pollution index was lower than 1971 but still existed (0.4705). Although there seemed to be a definite relationship between pollution and tree deteriorations, its nature was not clear. For instance, the discoloration and blemishes noted on the needles in the most polluted areas were not characteristic damages of SO2. Young tree seedlings were planted in a polluted area with 0.5-0.6 mg SO3/day/100 sq m. Most seedlings died due to transplantation rather than pollution. The sulfur content was high in the leaves of eucalyptus, coral trees, rose of sharon, and sweet oleander.
Source: 1

#1883
Ure, A.M. and C.A. Shand. "The determination of mercury in soils and related materials by cold-vapour atomic absorption spectrometry." Anal. Chim. Acta, 72(1):63-77 (Sept. 1974).

A method for the determination of mercury in soils and plant materials by cold-vapor atomic absorption spectrometry is described. The cold vapor atomic absorption technique differs from the usual bubbling technique in that the mercury in the sample solution is first partitioned between the liquid phase and a fixed volume of air by agitation before the latter is passed through the measuring cell since this method renders more reproducibility. Three preparative methods are developed, two of which use acid digestion and wet oxidation and the other direct oxidation in an oxygen-flask combustion technique. Excellent agreement obtained between the digestion method and the oxygen-flask combustion method for mercury contents from 0.09-0.26 micrograms/g indicates that these two radically different oxidation procedures are equally effective; agreement of these two methods with analyses by digestion, volatilization, and collection suggests that no significant matrix effects occur.
Source: 1

#1197
U.S.D.A. "Urban plants vs. pollution." Agricultural Research, 23(2):3-6 (August 1974).

Research is being done with red maples in their adaptability to air pollution and climate; and resistance to the disease Verticillium wilt. Also considered important are tolerance to drought, soil compaction, insects, as well as appropriate size, growth rate, and good form. Seedlings from certain areas are more tolerant to O_3 than those from other areas, thus suggesting genetic factors. Red maple seedlings which removed the most ozone from air were the most severely damaged as well. Thus, there has to be a compromise between removal ability and resistance. White birch seedlings were found to absorb considerably more O_3 per unit wt. of foliage than was red maple. Genetic adaption was also apparent with drought resistance and root compaction. It was found that Southern seedlings grew more rapidly than those from the North. One group of seedlings was found with a tolerance to the disease Verticillium wilt. Red maple seedlings took up more SO_2 than many other seedlings.
Source: 6

#536
U.S. Forest Service. "Trees for polluted air." U.S. Govt. Print. Off., 11 p. (1973).

Lists, representing the personal observations and reports of many international scientists, have been compiled of the known responses of both hardwoods and softwood to various pollutants: sulfur dioxide, hydrogen, fluoride, ozone, oxides of nitrogen, peroxyacetyl nitrate and others. The various plants are rated as being tolerant, sensitive or intermediate for each specific pollutant.
Source: 2

#709

Vanek, J. "Durch Industrieimmissionen verursachte Veraenderungen der Moosmilb en.schaften." (Industrial emission-generated changes in moss associations). Text in German. TERPLAN-Statni ustav pro uzemni planovani, Ustav Krajinne ekologie CSAV, Bioindikatory Deteriorizace Krajinny, Shornik Z Mezinarodni Konference, Prague, Czechoslovakia, p. 73-77, Sept. 1971.

Qualitative and quantitative changes in Acarina and Oribatoidea associations in the upper 5 cm layer of the soil due to increased soil temperature and the release of combustion products as a result of underground fires in a coal mine were studied by comparison with control growths. The absolute numbers of the species found in the damaged and control situations were 66 to 113, a difference of 41.6%. The density was 69.45% lower on the damaged than on the undamaged sites. The dominance of the Oribatoidea in the damaged group was lower by 27.5%. The qualitative and quantitative homogeneities in the damaged cenoses were 24.7% and 63.3% lower than in the undamaged cenoses. Species with low dominance were most damaged. Differenees in the site and time of the sampling influenced the results much less than the emissions.
Source: 1

#710

Vanin, A.F., A.A. Mutuskin, K. V. Pshenova, E.N. Frolov, D. S. Burbaev, and I. L. Lisovskaya. "Reaction of plant ferredoxin with nitric oxide." Mol. Biol. (English translation from Russian of: Molekulyarnaya Biologiya), 6(1):21-25 (1972).

The action of nitric oxide with pea leaf ferrodoxin was investigated. The absorption spectrum of oxidized ferredoxin did not change upon contact of the ferredoxin with NO. Absorption bands characteristic of oxidized ferredoxin in contact with NO and subjected to the effect of weak acid or dithionite. This band is probably due to a complex of NO with cysteine residues. An EPR signal of a nitrosyl complex of iron with cysteine was not found. The data obtained are examined on the basis of a persulfide model of the structure of nonheme iron complexes in ferredoxin
Source: 1

#271

Varhelyi, G. "Termeszetes es mestergeges eredetu szennyezoanyagok a legkorben." [Atmospheric pollutants from natural and man-made sources]. Idojaras (Budapest), 76(5/6):341-350 (Sept.-Dec. 1972).

Sulfur and nitrogen compounds of natural and anthropogenic origin in the atmosphere, and their interactions are reviewed. The emissions of natural pollutants such as carbon dioxide, carbon monoxide, hydrocarbons, hydrogen sulfide, nitrogen oxides, ammonia, and particulate matter amount to 140, 0.1, 0.1, 0.1, 0.5, 1.1, 1.2 and 0.2-0.4 billion tons yearly, respectively, compared to the values obtained for man-made emissions of these substances of 14, 0.28, 0.1, 0.003, 0.05 and 0.8-2.2 billion tons, respectively, with data on nitrogen compounds not being available. The anthropogenic SO2 emission is 140,000,000 tons yearly, originating mostly in combustion processes. Sulfur dioxide reaching high atmospheric levels oxidizes to sulfur trioxide to form sulfuric acid, while its photochemical oxidation in the presence of nitrogen oxides, olefins, and certain catalysts such as fog droplets and heavy metal ions, is of primary concern. Emitted SO2 is present in the atmos-

phere over about 4 days. Hydrogen sulfide, present in the atmosphere over 2 days, forms SO3 and finally sulfuric acid in the presence of ozone and water. Sulfur dioxide with ammonia can also form ammonium sulfate aerosol in the presence of humidity. Nitrous oxide, nitrogen dioxide, and nitric oxide may form nitrites and nitrates in the presence of humidity, solar radiation, and certain catalysts. Nitric oxide can combine with ozone to form NO2. The photodissociation of NO2 into NO and nascent oxygen, and the formation of and reaction with olefins of ozone constitute the basic mechanism of the formation of photochemical smog.
Source: 1

#1881

Veres, Imre, Janos Czibulya, Tibor Ravasz, Zoltanne Bozormenyi, and Andras Ochenyi. "Olajuzelesbol szarmazo pernyek fizikai, kemiai es mezogazdasagi vizsgalata, kulonos tekintettel a kotnyezetkarosito hatastra."(Physical chemical and agricultural investegations of fly ash originating from oil fired equipment, with special regard to the damaging effect on the envoronment). Energia Atomtech (Budapest), 25(7) : 318-321 (1972).

Physical and chemical investegations and greenhouse tests performed with fly ash samples from a large capacity, oil fired thermal power plant, are described. The vanadium content, determined by a colorimetric method, ranged from 3.82 to 4.14%, and the nickel content was determined by a gravimetric method as 0.59-0.62%. The bulk of the fly ash belonged in a fraction of 0.06-0.10 mm. A spherical, soot-like fraction and a mineral fraction with silica, iron oxides, and alkali earth metals as main components were distinguished by morphological investegations. The soot fraction, composed of spheres with smooth surface with limited adhesion represents minor envoronmental, including corrosion hazards, while the mineral fraction which contains hard, abrasive particles of very irregular shape with large specific surface may produce slight silicosis in man and animals, and plug the stomata in plants. In addition, this fraction represents low temperature corrosion hazards due to the presence of tetavalent vanadylsulfate and free sulfuric acid. Greenhouse tests with overdosed fly ash revealed white mustard (Brassica hirta) to be most sensitive for fly ash, which thus may be used as an indicator plant. The damage is also dependent on the water supply. The fairly high resistivity of leguminous species, especially of bean, may be due to the stimulating effect of vanadium and the increased heat absorption through the fly ash buildup.
Source: 1

#1880

Vetter, H. "Belastungen und Schaden durch Schwermetalle in der Naehe einer Blei-und Zinkhuette in Neidersachsen." Pollution and injuries by heavy metals in the vicinity of a lead and zinc plant in Lower Saxony). Staub, Reinhaltung Luft, 34(1):10-11 (Jan 1974).

The dusts emitted at 1 to 3 km distance from the lead and zinc plant in Lower Saxony from 1971 on contained about 15% Zn, 12% Pb, 1.4% fluoride, 0.2% copper, 0.15% arsenic and 0.09% cadmium. During the time if filter break-down in spring 1972 the average Pb concentration at 1.5 km distance

was about 12 mg and after repair of the filter 1 mg/sq m/day. Systematic measurement of the lead and zinc concentration in soil and plants to a distance of 12 km revealed that the lead and zinc concentrations in soil were up from the normal 10 ppm to 34 ppm Pb and 70 ppm Zn. At 12 km distance the grass contained in April about 100 times higher and in May about 10 times higher Pb concentrations than normal. At 1 km distance the Pb concentration in the grass rose to 23,000 ppm in April, dropped to 2000 ppm in May and to 50 ppm in September. The Zn concentration rose to 7000 ppm in April and dropped by September to 1000 ppm. Injuries of cattle observed in the vicinity of the plant were found to be mainly due to the zinc and lead ingested with the food. Feeding experiments with a Zn concentration triple the concentration of lead showed that Zn was more harmful than lead. Concentration limits for Zn are therefore as important as those for lead.
Source: 1

#1879
Viel, M. G. and M. L. de Cormis. "Action de l'anhydride sulfrex et des composes fluores sur la vegetation."(The effects of sulfur dioxide and of fluorine compounds on vegetation). Poll. Atmos. (Paris), 7: 381-391 (1965).

The study of the effects of SO2 and HF pollution on crops and vegetation grown around the industrial city of Lacq, France, which has daily emissions of 400 tons SO2 and 150 kg of fluorine, disclosed that in humid and cold years (1961, 1963) plant damage from SO2 predominated while in hot and dry years fluorine damage predominated. While SO2 causes burns immediately upon interaction with plant tissues, necroses produced by HF are slow in developing. Plants were the more susceptible to damage by SO2 the closer external factors came to achieving optimal photosynthetic activity. The sensitivity of luzerne to SO2 doubled when relative humidity was raised from 40 to 100%. Fruit trees manifested enormous differences in sensitivity as did grapevines. While the Petit Mauseign grapevine strain had an SO2 sensitivity threshold of 2.5 ppm, the Tannat strain's threshold was 15 ppm. Fluorine damage is best assessed on apricot trees, which are quite immune to SO2. The sensitivity threshold of plants to fluorine is 10 microg/cu m air. Analyses of sulfur and fluorine levels in plant tissue were of little help in diagnosing the cause of damage, in the case of sulfur because it is a major element of metabolism, and in the case of fluorine because some plants with a high fluorine content do not manifest damage while other plants with low fluorine content do. The various hypothesis of the mechanisims of damage by the two pollutants are discussed.
Source: 1

#1877
Vins, B. "Pouziti letokruhovych analyz k prukazu kourovych skod. Cast I. Metodicky prispevek k zpracovani letokruhovych analyz." (The application of annual ring analyses to the detection of smoke damage. I. A methodical contribution to the treatment of annual ring analyses). Text in Czech. Shornik Ceskoslovenske Akademie Zemedelskych Ved (Prague), 7(8):753-770 (1961).

Losses in growth gains of silvicultural stands caused by smoke emission can be measured by annual ring analysis. The method is advantageous mainly because the annual gains can be checked far into the past and thus compared with gains before the onset of the pollution. Experience gained in the Krusne Hory area of Czechoslovakia with the methodical processing of 2000 annual ring analyses is reviewed. The principal problem was found in the circumstance that more than half the trees exposed to pollution failed to grow annual rings. At first no rings are added from the ground up to a certain height of the tree; the defect then spreads all the way into the crowns of the affected trees. This observation is of fundamental importance in the calculation of losses in growth gains due to industrial emissions because hitherto the last annual ring next to the bark was always identified with the test year, while in reality a number of annual rings might already have failed to grow due to the effects of emmission. Thus errors far exceeding permissible limits might have occurred in the analysis.
Source: 1

#1876
Vins, B."Pouziti letokruhovych analyz k prukazu kourovych skod. II. Prispevek k hodnoceni letokruhovych analyz." (Application of annual ring analyses to the determination of smoke damage. II. Contribution to the evaluation of annual ring analyses). Text in Czech. Ustav Vedeckotechnickych Informaci MZLVH, 35(4):263-280 (1962).

The most emission-endangered forested areas of Czechoslovakia are Krusne Hory of Decinsky Sneznik. The condition of the forest cover today is such that not only the productivity of the forests but also their hydrological and ecological functions are in jeopardy. Measurements by annual ring analysis were made on trees at 102 selected experimental sites to determine the growth gain decrease due to air pollution. The decrease in growth gains was first noted in 1952. Up to 1958 this decrease was differentiated according to the degree of damage caused in different areas. Thus forests in the Chomutov area exhibited a 30% damage while forests in the Most and Teplice areas exhibited a 90% damage. In the Decinsky Sneznik area the growth gain drop was already noted in 1947 and from then on the annual growth impairment was about 15%. From 1953 on, this area suffered growth gain damage of the same magnitude as the Krusne Hory area. During 1954-1958, the growth gain decreases in four areas exposed to pollution of different severity were 23, 37, 40, and 70% respectively, compared to normal growth gains of trees grown in an unpolluted environment.
Source: 1

#1878
Vins, B., and R. Mrkva. "Zuwachsuntersuchungen in Kiefernbestanden in der Umgebung einer Duengerfabrik." (Increment studies in scotch pine stands in the vicinity of a fertilizer factory). Text in German. (Presented at the International Symposium of Forest Fume Damage Experts, 7th, Essen, West Germany, Sept. 7-11, 1970.) Mitt Forst. Bundesvers, 97:173-194 (1972).

Scotch pine stands growing in sandstone in a very dry region of Southern Moravia in the vicinity of a fertilzier factory were studied. Atmospheric pollutants from the plant included sulfur dioxide, sulfuric acid mist, and fluorine compounds. Permanent plots were established in the surrounding pine stands, with the plots being positioned so that the effects of decreasing amounts of pollution could be studied. Ring analyses were made on the cores from 100 sample trees in each of the five plots. Disturbances in the annual ring formation and reductions in growth were noted among the sample trees; similar disturbances were found in the smoke-damaged spruce stands of the Erzebirge. The structural characteristics and health conditions of the treeswere evaluated by computer.
Source: 1

#1875
Violet, P. "Generalites sur la pollution atmospheric. Mesures des niveaux de pollution dans l'agglomeration Lyonnaise." (Determination of the pollution levels in the Greater Lyon area). Text in French. Poumon Coeur (Paris) 26(6):1970.

The composition of pollutants from combustion, from industrial sources and from internal combustion engines is discussed and the clinical, chronic and cancerous manifestations stemming from atmospheric pollution, the effects of atmospheric pollution on plant and animal life and the criteria for the determination of maximal permissible levels of sulfur dioxide, carbon monoxide, of nitrogen oxides, of ozone, of carcinogenic pollutants and of inert dusts are outlined. Results of continuous monitoring of CO, carbon dioxide, SO_2 and of dust fall levels by 27 stations located in the industrial complex comprising Lyon, Villeurbanne, Saint-Fons, Feyzin, Venissieux, Saint Priest, Irigny, Pierre Benite and Sainte Foy from 1961 to 1969 are presented in the form of tables and graphs. The median daily level of SO_2 emission was 185 microg SO_2/cu m air, that of black dust emission was 134 microg/cu m air. The highest level measured at the center of Lyon was 1002 microg SO_2/cu m air in January. The median monthly CO_2 level was 0.4% in winter and 0.35% in summer. Five percent of all air samples taken at crossroads exhibited a CO level exceeding 40 ppm CO.
Source: 1

#305
Vitaliano, D.B. "Fluorine-bearing ash from the Hekla eruption, 1970: distribution, effect on environment, and implications for Mediterranean archeology and geomythology." In: Boston College Environmental Center Summer Institute on Surtsey and Iceland. National Aeronautics and Space Administration; Moffett Field, Calif., Ames Research Center, NASA TM X-62,009, p. 65-68, Feb. 1971.

In addition to its effect on the environment in Iceland, the occurrence of fluorine-bearing ash in the 1970 eruption of Hekla, as in the 1947 eruption of that volcano, has interesting implications in connection with Mediterranean archeology and geomythology. It seems likely that the 1970 eruption of Hekla may furnish a clue as to how the Santorin eruption of 1450 B.C. could have been responsible for the adverse effects caused to the plants, cattle, horses, asses, camels, oxen, and sheep of the Egyptians who were downwind of the eruption.
Source: 1

#27
Vogl, M. "Physiological and biochemical contributions to smoke damage research." Deutschen Akademie der Landwirtschaftswissenschaften, Dept. of Forest Plant Physiology, Institute for Forest Plant Growth. Graupa, Berlin, pp.587-594 (1964).
air and the damage effect upon the plant distinguishing between "offered" and "accepted" quantity (further divided into harmless and effective amount) to see if accepted quantity could be effectively measured. Author measured assimilation and SO_2 acceptance simultaneously and continuously. Found that SO_2 gasification initially leads to a depression of net assimilation and SO_2 absorption. Needles and parts of needles damaged only physiologically recover upon cessation of SO_2 gasification. Assimilation is retarded only by true damage.
Source: 8

#1874
Vogl, Michael. "Untersuchungen ueber Unterschiede in der relativen SO2-Resistenz bei Kiefern- Nachkommenschaften." (Relative SO2 resistance of pine progeny). Arch. Forstw., 19(1):3-12 (1970).

The intraspecific differences in resistance to sulfur dioxide were studied on stands of Pinus silvestris and its hybrids to determine whether resistance of hybrids to SO2 is influenced by parental resistance. The testing was accomplished by the exposure of cut-off branches to gaseous SO2 (the Vogi-Boertitz method 1968) and of potted plants to 22 ppm SO2 for a period of three days. In all instances, the degree of resistance of parental strains was observable in the degree of resistance of the progeny. These results are in agreement with results of a comparable study of the resistance of larch-tree hybrids to SO2 (1964). Of the experimental pine cones, one in particular yielded highly resistant progeny. The discovery of differences in relative resistance to SO2 in various populations of Pinus silvestris has implications for the selection of appropriately SO2 resistant clones on the production of seedlings.
Source: 1

#110
Waggoner, P. E. "Plants and polluted air." Bioscience, 21:455-459 (1971).

Presents a model for studying the removal of ozone from the atmosphere by plants; based on gas exchange theory and stomatal resistances (same resistances which oppose the transpiration of H_2O also oppose the uptake of ozone, and, perhaps, SO_2). ATMOZ, Fortran program constructed to simulate cleansing of air by vegetation. Applies model to ozone profile of Los Angeles and nearby countryside. Results of simulation and observed figures indicate that vegetation that survives pollution may be important factor in cleansing air.
Source: 2, 6, 7

#73
Waggoner, P. E. "Role of plants in improving the environment." J. Environ. Quality, 1(2): 123-127 (1972).

Foliage, especially foliage that is well watered and rapidly taking in carbon dioxide, improves our environment in tangible ways as well as aesthetically. Properly arranged, foilage can shade us without stilling the breeze and thus balance our energy budgets comfortably. When the productivity of crops per acre is increased, this free land for parks and wilderness, plants can also heal scarred land and scavenge pollutants from waste. Foliage can take in air pollutants. The assimilation of ozone by foliage can significantly cleanse the air of pollutant ozone much as the photosynthesis of a crop can decrease the carbon dioxide concentration of the air. The resistance to ozone uptake is the same as the resistance to transpiration of water. A mathematical simulator for estimating whether foliar uptake is significant or merely interesting is illustrated.
Source: 6

#743
Waggoner, P.E. "How trees scrub the air." Conn. Woodlands, 37(4):14, 17, 18 (Winter 1972/73).

The author talks about trees removing harmful gases from the air. He relates the conditions under which the greatest absorption occurs.
Source: 2

#244
Wagner, K.-H. and I. Siddigi. "Abhaengigkeit des Bleigehaltes der Pflanzen von der Bleikonzentration im Boden." (Dependence of the lead concentration of plants on the lead concentration in the soil). Naturiwissenschaften (Berlin), 60(4):200 (1973).

The lead concentration of vegetables grown in the vicinity of highways and in industrial centers has grown in recent years. The explanation frequently

given is that the vegetables are being directly contaminated by the lead-containing aerosols of the atmosphere. The reduction of the lead level by washing is suggested. In cabbage harvested 25 m from a highway, 125 ppm lead were measured in the leaves, and after washing 11.6 ppm; in the innermost nucleus 7.0 ppm and after washing 2.3 ppm were measured. The lead fraction which can be washed off is variable, and the remaining lead concentration is indicative of the resorption capacity of plants for heavy metals. The resorption rate of lead by barley was determined by the Mitscherlich method. Two, 20 and, 40 mg lead were added in form of lead nitrate to 6 kg soil each time. The plant did resorb lead from the soil dependent on the lead concentration in the soil.
Source: 1

#1119
Wainwright, C.W.K. and M.J.G. Wilson. "Atmospheric pollution in a London park." International J. of Air and Water Pollution, 6 (1962).

The concentration of atmospheric sulphur dioxide was recorded at a point in Hyde Park, London, and traverses of the Park were made with portable apparatus. The rate of decrease of concentration with distance from the upwind edge was found to be closely related to the lapse rate but not to the wind speed. The rates of decrease with distance were greater than those calculated from the work of Lucas, and even large adjustments to his treatment would not make it fit all the experimental results. It is suggested that the discrepancy may be partly due to a current of cleaner air which descends into the Park by natural convection.
Source: 8

#118
Walker, K.C. "Agricultural practices influencing air quality." In: Agriculture and the Quality of Our Environment, N.C. Brady (ed.), AAAS Publication #85, p. 105-111 (1967).

Reviews problem of agriculture and air pollution. Makes 3 major points. 1. Air quality is influenced by any energy conversion, be it natural or man-caused; 2. citesagricultural practices which contribute to air pollution (although a relatively small contribution). These are (a) soil erosion (particulates), (b) use of pesticides, (c) allergenic pollens, e. g., ragweed, (d) chaff from post-harvesting operations, (e) animal wastes, (f) odors and dusts from handling agricultural products. 3. greatest influence of vegetation is beneficial - removes organic toxicants and suspended particulates.
Source:7

#1134
Wallace, D. A. (ed.) Metropolitan Open Space and Natural Process. Univ. of Penn., Philadelphia. 199 p. (1970).

The central concern of the study in the preservation of open space around metropolitan areas. By preserving the natural environment, at the same time, it provides for future development and provides a logical sequence and direction for urban growth. The areas that should be particularly preserved are those in which development may severely alter the environment and/or those that are important in maintaining a stable urban hydrology.
Source: 8

#1873
Wallis, W.J., G.W. Miller, M. Psenak, and J. Shieh. "Fluoride effects on chlorophyll biosynthesis in Nicotiana tabacum." Fluor., 7(2):69-77 (April 1974).

The effects of chlorine and fluorine on the biosynthesis of chlorophyll were investigated in Nicotiana tabacum. The effect at different concentrations (0.0001 M, .001, and .01 M) was investigated on the incorporation of 14 Carbon-delta-aminoleuvulic acid (ALA) into coproporphyrin and protoporphyrin fractions, and ether-extracable pigments (chlorophyll a and pheophytin a) in tobacco leaf discs. Both chloride and fluoride at concentrations of .0001 to .01 M inhibited the incorporation of ALA into chlorophyll a and phelophytin a. At 0.01 M the effect of fluoride on AIA incorporation was greater than that of chloride. The inhibition on formation of phelophytin a by fluoride was similar to that found in chlorophyll a, indicating an effect on synthesis of chlorophyll rather than degradation. The effect of fluoride on individual enzymes in the chlorophyll biosynthetic pathway is discussed in relation to the action of fluoride on cellular ultrastructure.
Source: 1

#1872
Wander, I.W. and J.J. McBride, Jr. "Chlorosis produced by fluorine on citrus in Florida. Science, 123:933-934 (May 25, 1956).

A unique chlorotic leaf pattern on citrus trees in Florida that is attributed to fluorine is reported. The chlorosis was first noted in Polk County in April 1950 and was associated with a triple superphosphate manufacturing plant that recently opened. The polluting condition was corrected, but as new triple superphosphate plants opened, chlorosis increased. Florida pebble rock phosphate contains 2-4% fluorine which is released during the production in triple superphosphate. Chlorotic leaves from affected groves ranged in fluorine content from 370 ppm to as low as 48 ppm. Chlorotic citrus leaves were observed up to 6 miles away from the nearest plant, but the leaves were not abnormally high in fluorine content. It appears that fluorine causes leaf chlorosis and is then dissipated by translocation. Normal appearing leaves away from the affected area contained from 12 to 30 ppm fluorine. In 1955 sprays of aqueous acids were applied at concentrations 0.1N to 4 year old Ruby Red grapefruit trees located 20 miles from the nearest triple superphosphate plant. Seven sprays of 1 l of solution each were applied during a 2 month period,and an identical chlorotic leaf pattern emerged in the trees sprayed with hydrofluoric and fluosilicic acid. Citrus trees in California that contained up to 211 ppm fluorine did not develop chlorosis and may be the results of differences in climatic conditions, primarily the higher humidity in Florida.
Source: 1

#882

Wander, I.W. "Effects of pollutants on vegetation (with special reference to the effect of fluorine on citrus)." Fla. Eng. Ind. Expt. Sta. Bull., Eng. Progr. Univ. Florida Bull. Ser., 10(9):14-16 (Sept. 1956).

Following the construction of several triple-superphosphate manufacturing plants in Polk County, Florida, a unique chlorotic pattern developed on citrus leaves, particularly grapefruit. The condition differed from known chloroses resulting from nutritional deficiencies or toxicities and was eventually traced to the fluorine being released by the phosphate plants. The fluorine content in the chlorotic leaves ranged from 370 ppm to a low of 48 ppm. These findings are noted to contradict a California study which reported no instances of chlorosis in citrus leaves that were found to contain up to 211 ppm fluorine. The fact that chlorosis develops in Florida may be due to the higher humidity under which the leaves mature.
Source: 1

#1840

Ward, N. I., R. R. Brooks, and R. D. Reeves. "Effect of lead from motor-vehicle exhausts on trees along a major thoroughfare in Palmerston, North, New Zealand." Environ. Pollut. 6(2):149-158 (February 1974).

The effect of lead from motor vehicle exhausts on trees growing along a busy thoroughfare in Palmerston North, New Zealand, was investigated. Analysis of tree samples (leaves, bark, and trunk cores) and of soils, showed that the distribution of emitted lead was influenced by the direction of the prevailing wind. Lead levels were higher on the sides of the trees facing traffic. Measurements of lead concentrations in leaves, bark, and soils showed considerable accumulation in the vegetation at distances of about 5 m from the main traffic movement. Lead levels increased from ground level up to 1-2 m, then decreased.
Source: 1

#1839

Warmbt, W. "Die Abhaengigkeit der SO2-Konzentration on meteorologischen Einflussgroessen im Rauchschadengebiet des Erzgebirges." (Dependence of the sulfur dioxide concentration of meteorological influences in the smoke-damaged area of Erzgebirge). Text in German. Erfassung Auswirkungen, Luftverunreinigungen, Vortr Lufthyg. Kolloq, 3rd, p. 167-184 (1972).

Results of the long-term monitoring of the sulfur dioxide concentrations and meteorological parameters in the smoke-damaged coniferous forest of Erzgebirge in East Germany are presented. The SO_2 concentrations were highest during anticyclonal conditions with winds from the Bohemian industrial basin. Such conditions occurred on about 90 days of the year. The SO_2 concentrations measured during cyclonal periods with winds from the opposite direction were low. The evaluation of the number of days with anticyclonal conditions and winds from the Bohemian Basin and of the days with SO_2 stress led to the same result. To considerable growth depression in the 1961-1964 period was due only partly to the above-average percentage of periods with SO_2 influence.
Source: 1

#245
Warren, H. V., and R. E. Delavault. "Observations on the biogeochemistry of lead in Canada." Trans. Roy. Soc. Can., Sect. IV, 54:11-20 (June 1960).

Workers in other countries have found lead in most vegetation which they have analyzed, usually in the range of from 10 to 100 ppm in ash. In Western Canadian vegetation we have noted significant variations in the lead content of various species of trees and lesser plants growing in close association: obviously vegetal matter differs widely in its capacity to absorb lead. Probably the most far-reaching result of our investigations has been to learn that some gasoline exhaust fumes are responsible for higher concentrations of lead in vegetation close to highways than any other cause yet encountered: concentration of over 1000 ppm in ash have been noted in vegetation from several localities. Only vegetation growing close to significant lead mineralization shows comparable concentrations.
Source: 1

#364
Warren,H.V., R.E. Delavault, and K.W. Fletcher. "Metal Pollution - a growing problem in industrial and urban areas." (Presented at the CIM, General Meeting, Annual 73rd, Quebec City, April, 1971.) Can. Mining Met. Bull. (Monreal), 64(711):34-45 (July 1971).

A preliminary study of soils, vegetables, variegated vegetal matter, and dusts deomstrates quite clearly that metal contamination is as severe in many cities as it is around some of the best known metallurgical centers. Soils from both Sudbury and Noranda were found to be high in copper, while those from Riondel, Trail, and Noranda had higher than normal amounts of zinc, lead, and cadmium. Liverpool beets, lettuce and cabbage were found to contain more zinc than those vegetables grown in the vicinity of Noranda. Lettuce grown in Vancouver was found to have more lead than lettuce harvested within the orbit of Trail's contamination.
Source: 1

#711
Warren, H.V., R.E. Delavault, K. Fletcher and E. Wilks. "Variations in the copper, zinc, lead, and molybdenum content of some British Columbia vegetables." Missouri Univ., Columbia, Proc. Missouri Univ. Fourth Annu. Conf. Trace Substances Environ. Health, Columbia, Missouri, 94-103 (1970).

Samples of many British Columbian vegetables collected from 30 different gardens were analyzed for copper, zinc, lead, and molybdenum. Some vegetables actually had 500 times more Mo than others. Even Zn, which has the most restricted range of the four elements investigated, is 40 times more abundant in some vegetables than in others. Vegetal trace element concentrations that vary from what are becoming to be thought of as normal can usually be explained in terms of the pH, organic content, soil type, climate topography, degree of pollution, and/or geological background of the related soil. However, some deviations from the normal cannot yet be readily explained.
Source: 1

#1838

Warren, H. V., R. E. Delavault, K. Fletcher, and E. Wilks. "A study in lead pollution." West. Miner, 1971:1-4 (Feb. 1971).

Lead contents in settling dust, soil, fodder, and food crops grown near an intersection of two busy highways in Richmond, British Columbia, were determined. Settling dust collected near the intersection contained up to 42,000 of lead, and lead contents of 1400 to 2250 ppm were found in soil samples within a radius of about 1000 feet of the intersection. Fodder grown within about 1000 yards of the intersection contained lead concentrations of 15 to 5560 ppm dry weight. The lead contents in unwashed vegetables ranged from 2.9 to 9.2 ppm wet weight. Hence, it would seem prudent to avoid growing vegetables for the public market within the intersection area. However, if the plants are washed and carefully prepared, the amount of lead ingested from the early season vegetables would be comparable with what is ingested from many other areas in Canada.
Source: 1

#85

Warren, J. L. "Green space for air pollution control." School of Forest Resources, North Carolina State Univ., Raleigh, Tech. Report No. 50 (July 1973).

Green space is land covered with some form of vegetation - grass, shrubs, or trees. This report is particularly focused on that green space covered by woody vegetation, especially trees.

The roles of plants and soil as sinks for air pollution and the filtering and sorption effects of vegetation on air pollution are reviewed. The effects of vegetation on the urban microclimate are discussed; a summary of meteorological factors to be considered in green space management is given. Management considerations for green space used for air pollution control include Russian, European and American experiences.

Airsheds, air zoning, air easements, land banking, transportation planning, and examples of man-oriented planning are integrated with the available basic research to serve as a guide for the management of green space for air pollution control.

The use of green space for control of an unique form of air pollution - noise - can be a concomitant objective of green space management for air pollution control. Factors influencing the transmission and absorption of sound by vegetation and the design of green space for noise abatement are discussed.

Based upon what is known, a prototypical program of further research and development is presented. Basic and applied research needs are included.
Source: 7

#1243
Warrick, A. W. and S. Miyamoto. "Land disposal of waste gases: II. Gas flow from buried pipes." J. Environ. Quality, 3(1):55-60 (Jan.-March 1974).

Steady-state compressible gas flow in homogeneous soils from buried porous pipes were analyzed for the purpose of developing land disposal systems for waste gas absorption. Two different cases are considered: the ground surface partially covered by an impermeable barrier; and the surface corrugated with alternating ridges and valleys with the pipe buried under the ridges. The partial surface barrier provides a more uniform gas flow in soils than without it, but leads to an increase in the power required to inject gas at a given rate, especially when the pipe spacings are wide. Compared to an open level surface, the corrugated geometry results in a better gas distribution with little increase in power required and is probably the better system for injecting waste gas in nonstratified soils.
Source: 1

#1835
Warteresiewicz, Maria. "Einfluss der Luftcrunreinigangen auf Pflanzen in der Naehe einiger Zinkhuetten." (The influence of air pollution on plants in the vicinity of some zinc works). Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland. 185-195 (1968).

Studies were made in 1965/66 in the vicinity of two zinc works in the Upper Silesian industrial district to determine decreases of the yield of crops, the influence of emissions on the chlorophyll content of plants, and effects on water content of plants. The gaseous emissions are sulfur dioxide and nitric oxide in substantial concentrations; dust emissions contains zinc, lead, cadmium and copper. The control points were located at varying distances between 0.4 and 2.5 km from the works in different directions. Considerable damage to clover was found at times, with partly burned leaves which then died and dropped off. During some periods crop yields decreased by 70% below normal in case of potatoes, 60% for clover, and 50% for beans. The chlorophyll content in damaged plants decreased. During the period of plant growth, tests were made to determine the loss of water in plants after they have been cut, by weighing the plant every hour after cutting for up to five hours. After five hours healthy bean leaves lost 43% of their weight, while damaged leaves lost 65%.
Source: 1

#1837
Warteresiewicz, M., and I. Szalonek. "Untersuchungen ueber die Schaden an Kulturpflanzen in der Naehe eines Metallurgischen Kombinates." (Investigations on the damage to crop plants near a mettalurgical combine). Test in German. (Presented at the International Symposium of Forest Fume Damage Experts, 7th, Essen, West Germany, Sept. 7-11, 1970.) Mitt Forst. Bundesvers, 97:209-217 (1972).

The effect of air pollution on crops was investigated in the vicinity of a large ironworks. The air pollution measurements indicated a high sulfur dioxide level and a high dust content. The unfavorable effect of the pollution on the plants (planted in wooden boxes in uniform soils) was obvious growth rates were reduced, water loss through the leaves was accelerated, and there were changes in the levels of assimilation pigments. The damage to the plants was irregular and occurred in differing degrees; the number of species suffering damage was high. The yields were lower than among control plants. Losses of up to 40% were sustained by potatoes and fodder beets, although losses of barley were smaller. The lower yields are particularly noticeable in the second year of the experiment when the incidence of acute damage was very high.
Source: 1

#1836
Watanabe, J., and S. Amano. "Arumina seiren kojo kinsetu onshu mikanen ni okeru kakushu enrui yoeki no yomen sanpu ga higaiju no rakuyoritsu ha no ku roroshisu kaifuku narabi ni kekkaritsu ni oyobosu eikyo." (Effects on foliar spray of mineral solutions on the leaf fall, recovery from foliar chlorisis, and fruit set of contaminated Satsuma mandarins grown in the vicinity of an alumina-refining factory.). Text in Japanese. Ehime Daigaku Noagakbu Kiyo (Mem. Coll. Agric., Ehime Univ.) 18(1):143-155 (Aug. 1973).

Various chemical foliar sprays were tested for their efficacy in reducing fluorine damage to Satsuma mandarin fruit grown in the vicinity of an alumina refining factory. Foliar spray with lime exerted various desirable effects on the persistency of leaves, setting of fruit, titratable acidity of juice, and chlorophyll content of the leaves. Among the mineral elements in the leaves of the sprayed plants, only magnesium showed consistent changes with the application of various sprays.
Source: 1

#365
Webster, B . D. "Effects of air pollution on the growth and development of beans." Dept. of Agriculture, Agricultural Research Service, Dry Bean Res. Conf., 10th, Davis, Calif., Paper ARS-74-56, p. 24-33 (Aug. 12-14, 1970).

The effects of air pollution on the growth and development of beans are discussed. Air pollution damage accounts for 1/4 of the crop loss in California. The nature of the injury which bean plants sustain suggests the particular nature of the pollutant. For example, ozone, peroxyacetyl nitrate (PAN), ethylene, sulfur dioxide, and fluorine compounds produce a unique pattern of damage, leaving on the bean plant a graphic, visible

record of the particular air pollution episode. Some of the most typical morphological modifications of bean growth which result from pollutant exposure include flecking of the leaf surface, silvering or bronzing of leaves, breakdown of chlorophyll containing cells, and leaf flower drop. Physiological modification include a loss of the selective permeability of cell membranes, a decrease in carbon dioxide fixation, an inactivation of the growth hormone indoleacetic acid, and a blockade or retardation of starch hydrolysis. Investigations designed to alleviate air pollution damage to beans involves studies of the control of the dissemination of air pollutants the breeding and development of resistant bean varieties, the periodic renewal of growth hormones by spraying and the direct application of certain compounds known to increase the tolerance of beans to pollutants.
Source: 1

#1834
Webster, C. C. "The effects of air pollution on plants and soil." London, Agricultural Research Council, 53 p. (1967).

Recent trends in the emissions and concentrations of smoke, deposited matter, and sulfur dioxide in Britain and the effects of these pollutants on plants and soil are presented. Factors affecting the action of sulfur dioxide on plants are susceptibility of different species and varieties, stage of growth, time of day, environmental conditions, concentration of gas and time of exposure, intermittent exposure, and fluctuating concentration of gas. The effects on plants and soil of fluorides and photochemical or oxidant smog are considered. The contamination of plants near highways with lead from the exhaut fumes of motor vehicles is included. Plants as indicators of pollution are also discussed.
Source: 1

#143
Wedding, J. B., R. W. Carlson, J. J. Stokel, and F. A. Bazzaz. "Aerosol deposition on plant leaves." Environmental Science & Technology, 9:151-153 (1975).

An aerosol generator and wind tunnel fumigation system designed for use in studies of aerosol deposition on leaf surfaces is described. Gross deposition on rough pubescent leaves was 10 times greater than on smooth, waxy leaves. Results suggest that aerosol deposition, on a per unit area basis, for single horizontal streamlining leaves, is similar to that for arrays of leaves under similar flow conditions.
Source: 7

#1099

Weeb, W. L. "Effectiveness of plants as buffers against pollution." Oregon State University. Corvallis. Forest Research Laboratory.

Objectives:
A preliminary study is proposed to evaluate the effectiveness of Douglas-fir and/or red alder in absorbing sulfur dioxide from the atmosphere or elemental mercury from streams. Implicit in this objective is the determination of ambient contaminant concentrations that impair normal plant function.

Approach:
Response of plants to SO(2) and/or mercury will be determined by measuring the contaminant-induced reduction in net photosynthesis. Pollutant uptake at harmless ambient concentrations will then be determined with an ^{35}S analysis by neutron activator analysis. The plants will be exposed to SO(2) and mercury, gas-tight controlled environment system.

Progress Report: 72/01 72/12
The project terminated after a system for monitoring and controlling radioactive gases was incorporated into the existing controlled environmental system. An ion chamber and Carey electrometer were coupled to a controller that was designed and fabricated in-house. Specific activity of radioactive gases can be held constant in the system. Douglas-fir seedlings were exposed to low levels of (14)CO(2) at ambient CO(2) concentrations, 330 ppmm. Plant parts were combusted, (14)C determined, and total carbon absorbed and translocated was quantified. The same technique could be used for atmospheric contaminants that have a suitable isotope, such as (35)SC(2).

Publications: 00 additional publications.

No publications reported at this period.
Source: 6

#712

Wei, L., and G.W.Miller."Effect of HF on the fine structure of mesophyll cells from glycine max, merr." (Presented at the International Society for Fluoride Research, Annual Conference, 4th, the Hague, Netherlands,Oct. 24-27, 1971.)

The effects of hydrogen fluoride on soybean leaves fumigated with 40-50 ppb HF were examined. In the cytoplasm the presence of small vacuoles was the first noticeable initial change. The fragmentation of the vacuolar membrane occurred either simultaneously or followed immediately. Lipid-droplet-like globules and numerous vesicles occurred subsequently in the cytoplasm and increased as the injury became more severe. There was a decrease in polysomes and a detachment of ribosomes from the rough endoplasmic reticulum. Free ribosome concentration also decreased as the injury became severe. Mitochondrial modifications involving dilation of outer and cristae membranes followed by reduction of both cristae number and matrix electron density and the disappearance of mitochondrial granules were observed in the chlorotic leaves. Electron dense inclusions accumulated in some mitochondria. The first noticeable change observed in the chloroplast was the presence of clusters of phytoferritin granules within the stroma after only 2 days of fumigation. Alterations in nuclear structures were observed in later

stages of injury. Numerous small electron dense particles were found in various types of membranes in cells of severely chlorotic leaves. They were distributed on outer mitochondrial membranes, endoplasmic reticula, dictyosomes, tonoplasts, plasmalemma, nuclear envelopes, and disintegrating organelles and vesicles, but were never observed on membranes of chloroplasts and microbodies.
Source: 1

#279
Weickmann, H.K. and R.F. Pueschel. "Atmospheric aerosols: Residence times, retainment factor and climatic effects." Beitr. Physik Atmosphaere, 46(2): 112-118 (1973).

A retainment factor (R) for atmospheric aerosols has been definded as the fraction of the annually produced aerosol mass which is retained by the atmosphere. Its application to various aerosol systems leads to the following conclusions: A range for R between .00001 and 1.0 exists. Consequently, different aerosol systems affect climate to different degrees depending on their physical-chemical properties and their injection level within the atmosphere. Also, 11.5% of the total aerosol burden is anthropogenic. It is produced, however, on only 2.5% of the earths surface leading to numerous cases of inadvertent weather modification. From a combination of annual production rates, retainment factors and a climatic model proposed by Barrett, it follows that man is responsible for a global temperature change of about 0.1 C below that for a clear atmosphere. This is less than the contribution of each of various natural aerosol systems such as sea-salt, soil dust, and the volatile portion of the natural aerosol. From presently existing energy requirements it is estimated that in about 23 years man will be compatible with nature in aerosol production. By improved emission control techniques, however, it should be possible to control aerosol production and to avoid man-made global climatic consequences.
Source: 1

#1603
Weidensaul, T. C. "Are trees efficient air purifiers?" Ohio Rep., 57(4):57-60 (July-August 1972).

When viewed in their proper perspective, the value of plants as air purifier and suppliers of oxygen is questionable. The amount of oxygen emitted and the amount of carbon dioxide absorbed can be calculated from the amount of carbon produced in any given ecosystem. However, there have been few, if any, attempts to monitor ambient air for the amounts of oxygen produced by an acre of trees or CO_2 removed from the atmosphere over this same acre. Tables are presented which depict the relative importance of plants as oxygen producers. Nearly 88% of all oxygen produced on earth through photosynthesis originates in the sea. The relationship of oxygen production and CO_2 consumption to plant vigor and the rate of growth of the plant is a direct one. Another interesting way of viewing the importance of green plants in oxygen production and CO_2 consumption is by replacing these functions to human respiration requirements.
Source: 1, 6

#1200
Weidensaul, T.C. "The importance of trees in oxygen production and air purification." (Non-published article from the Ohio Agricultural Research & Development Center, Wooster, Ohio). 11 pp. (1972).

Research has shown that plants may not be efficient air purifiers. Forests role in producing oxygen is not as significant as some people imply. In fact, about 88% of the O_2 produced is from green plants in the ocean. We must determine just how much O_2 and air contaminants are consumed by the immediate environment in which those plants are grown. If we attempt to increase O_2 amounts in the atmosphere, the photosynthesis rate may decrease. The atmospheric amounts of CO_2 and O_2 remain fairly constant throughout the year. This implies that the effect of plants on O_2 levels is relatively insignificant. Tables of O_2 production and CO_2 uptake are included.
Source: 6

#246
Weigl, J., and H. Ziegler. "Die raumliche Verteilung von S und art der markierten Veriindungen in spinatblatterr nach Begagung mit SO2." (The special distribution of 35S and the variety of the marked compounds in spinach leaves after gasing with 35SO2). Translated from German. Belov and Associates, Denver, Colo., 18 p., Feb. 17, 1970. Planta, 58:435-447 (1962).

Investigations were conducted on the special distribution of S(35) in spinach leaves after exposure to 50 ppm SO2 (35). For experimentation with radioactive gases, a device was constructed consisting of a Handschvh-kammer and a gas chromatograph. This device permitted safe handling of the radioactive gases. An electrophoretic method for separating sulfites, sulfates, and sulfurous amino acids, and N-Ethylmaleinimide compounds with amino acid containing sulfur is given. The SO2 was detected by gas chromatography. The distribution of S(35) in the spinach leaf after exposure to SO2(35) was studied microautoradiographically. After seven hours of exposure, a 2- to 5-fold enrichment of S(35) in the guard cells of the pore openings was observed with respect to the remaining epidermal cells. A portion of the S(35) also entered the vascular paths. The chemical distribution of S(35) was also studied. The result was the rapid installation into cysteine, glutathione, and unknown soluble and insoluble sulfur compounds. The oxidation of sulfite to sulfate also occurred. The results are discussed with respect to the mechanism of the toxicity of SO2.
Source: 1

#42
Weigl, J., and H. Ziegler. "The spatial distribution of S^{35} and the variety of the marked compounds in spinach leaves after gasing with $S^{35}O_2$." Planta, 58:435-447 (1962).

Author describes method for working with S^{35} in Handschvkanner with gas chromatograph and gives an electrophoretic method for separation of sulfite, sulfate, sulfurous amino acids, and N-ethyl maleinimide compounds with S- containing amino acids. Limit of detection of SO_2 by chromatography is 20 ppm. After 7 hours of gasing with 50 ppm a 2-5 fold enrichment of the isotope in stoma guard cells was observed with respect to epidemis cells. Some S^{35} enters vascular pathways. Chemically, $S^{35}O_2$ rapidly installed into cysteine, glutathione, an unknown soluble as well as insoluble S compounds and great oxidation of sulfite to sulfate. Results discussed with respect to toxic effect of SO_2.
Source: 8

#1833

Weiler, A. "Durch Saeuren und teerige Stoffe hervorgerufene Aetzschaeden an Blattorganen." (Corrosive damage on foliage organs caused by acids and tarry substances). Translated from German. Photopathol. Z., 7:121-144 (1934).

Numerous cases of corrosive damage to plant foliage caused by hygrophilic acids and tarry substances are presented. Sulfuric acid-laden soot particles from the smokestack of a factory caused spot damage to nearby plants, though the effects varied depending upon the type of plant investigated. Hydrochloric acid causes a peculiar ring formation on plant leaves, and the damage is not limited to the top side of the leaves. Both hydrochloric and H_2SO_4 diffuse into the needles of spruce, thereby killing assimilatory cells. Chlorine-caused white spots appeared on sugar beet leaves as a result of chlorophyll destruction. Dead cells were found in the vicinity of the stomata and lower down in the mesophyll. Corrosive damage caused by tarry substances is a black to brown discoloring resulting from the precipitation of tanning agents caused by basic substances in the cells of mesophyll or mesophyll and epidermis. The deposits first form in living cells in the shape of small balls, and eventually the cells die, with their contents solidified into compact masses. Coking plants are the most important source of tar damage to plants since their emissions contain all distillation products of bituminous coal in addition to soot.
Source: 1

#1829

Weinstein, Leonard H., Jay S. Jacobson, and Richard H. Mandl. "Fluorine-Semiautomated method." J. Assoc. Offic. Anal. Chemists, 55(5): 998-1003 (Sept 1972).

A semiautomated, colorimetric method for the analysis of fluoride in vegetation is presented. Dried and ground plant material is ashed, fused with alkali, and diluted to volume. Leaf samples may be washed with an aqueous solution containing 0.05% detergent and 0.05% tetrasodium ethylene diamine tetracetic acid salt. The digest and sulfuric acid are then pumped into microdistillation apparatus which is maintained at 170 C.A stream of air carries the acidified sample to a fractionation column where F and water are distilled into a condenser; the condensate passes into a small collector. The distillate is mixed continuously with alizarin F blue-lanthanum reagent, the colored stream passed through a tubular flowell of the colorimeter, and the absorbance measured at 624 mm. Conditions must be carefully controlled since accurate results depend upon obtaining the same degree of efficiency of distillation from samples as from standard F solutions used in calibration. The temperature must be maintained within plus or minus 2 C, and regulation of the acid concentration during distillation is achieved by taking plant samples in the 0.1-2.0 g range and by using specified amounts of calcium oxide and sodium hydroxide for ashing and fusion. Interfering metal cations and inorganic phosphate are not distilled, and organic substances are destroyed by ashing. Interference from remaining volatile inorganic anions is reduced with high concentrations of acetate buffer at the expense of some reduction in sensitivity. The method can detect 0.1 micrograms F/ml, and the normal range is 0.1-4.0 micrograms F/ml.
Source: 1

#247
Weinstein, L.H., R.H. Mandl, D.C. McCune, J.S. Jacobson, and A.E. Hitchcock. "Semi-automated analysis of fluoride in biological materials." J. Air Pollution Control Assoc., 15(5):222-225 (May 1965).

A semi-automated method for determination of fluorine in biological material has been developed incorporating the Technicon AutoAnalzyer. One-half of dried, ground plant material is pumped, along with H_2SO_4, at controlled rates, into the hot revolving glass helix of a digestor unit. As the acid-digest mixture passes through the heated coil, volatile fluoride and water vapor are evolved. The volatile fluoride and water vapor are pulled from the helix under reduced pressure through a tube which projects into the helix. The tube, in turn, is connected to a water-jacketed condenser and then to an impinger where the sample is continuously mixed. An aliquot of the impinger liquid is being constantly withdrawn. This sample is then air-segmented and mixed with a reagent containing alizarin complexone, PH4 acetate buffer, lanthanum nitrate, acetone, and water. The sample-reagent combination passes through 4 full length mixing coils where color development takes place. Upon reacting with fluoride, the wine-red alizarin complexone-La(III) reagent forms a lilac blue fluorine complex. The solution is pumped from the mixing coils through the tubular flow cell of the colorimeter. The absorbance of the solution is measured at 624 millimicrons, and the signal is transmitted to a recorder where the results are plotted on absorbency paper. The absorbence at the apex of the peak is proportional to the amount of fluoride in the sample between the range of 2.5-80 micrograms F. Samples are analyzed at a rate of 12 per hour. Results compare favorably with those obtained by Willard-Winter distillation. Recent studies indicate that the F content of plant tissues can be estimated without prior ashing and fusion.
Source: 1

#1832
Weinstein, L.H., and D. C. McCune. "Effects of fluorine on agriculture." Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 14 p., 1970. (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo., Paper 70-154, June 14-18 1970).

Certain effects of fluorine on plants can be regarded as objective since they have been derived from laboratory experimental data, field observations, and the body of botanical knowledge. Agricultural effects, on the other hand, are to a great extent hypothetical and subjective. The three general classes of possible effects of fluorine on agriculture are decreased commercial value of the product, increased cost of production, and decreased value of farming facilities. While experimental data cannot be used to predict all the fluorine effects that might occur in the field, experimental procedures do permit the identification and prevention of agricultural effects. The latter can then be the subject of limited field trials and surveys.
Source: 1

#1830
Weinstein, Leonard H. and Delbert C. McCune. "Implications of air pollution for plant life." Proc. Am. Phil. Soc., 114(1):18-21 (Feb 1970).

Identifiers: *Plant damage, *Pollutants, Leaves, Banding, Chlorosis, Necrosis, Plant growth, Photosynthesis, Metabolism, Engine exhausts, Odors, Particulates, Coal, Furnaces, Chemical processing, Fertilizer manufacturing, Primary metallurgical processing, Fluorides, Peroxyacetyl nitrate, Sulfur dioxide, Ozone.
The effects of an air pollutant on a plant may vary with respect to their manifestation and the circumstances of their occurence. The best known are the visible lessions that appear on the foliage taking the form of chlorotic or necrotic areas distributed on the leaf in patterns characteristic of the plant and the pollutant. In affected broad-leaved plants, fluoride symptoms appear as marginal areas of chlorosis or necrosis. Sulfur dioxide effects are irregular necrotic areas between the veins. The symptoms of ozone injury may be flecks or patches of dead tissue on the upper surface. Peroxyacetyl nitrate attacks the underside of the leaf, giving it a glazed appearance. In the narrow-leaved plants, the foliar symptoms of pollutant injury are banding of the tips of the leaves. There are other changes that are not immediately apparent in occurence or significance, such as effects on growth, yield, crop quality, physiology, and metabolism. Two basic approaches may be taken for control of pollutants that damge plants. The access of the pollutant to the plant may be restricted, or the pollution source may be removed from the receptor. It is also suggested that plants be developed that will be more resistant, or that practices be developed that will modify the response of plants to air pollutants. A brief history of the damaging effects of pollution on plants is presented.
Source: 1

#1831
Weinstein, L.H., D.C. McCune, J. F. Mancini, and P. van Leuken. "Effects of hydrogen fluoride fumigation of bean plants on the growth, development, and reproduction of the Mexican bean beetle." Proc. Int. Clean Air Congr., 3rd, Duesseldorf, West Germany, p.A150-A153 (1973).

The growth and behavior of Mexican bean beetle populations on control and hydrogen fluoride-fumigated bean plants (P. vulgaris L. cv. predominantly) were investigated to assess the effects of such fumigation on beetle growth, development and reproduction. Beetles that were cultured on HF-fumigated plants were generally lighter than controls, although the occurrence and magnitude of this effect depended upon stage of development, age, and sex of the adult beetle and the number of generations of culture on HF-fumigated plants. A consistently decreased mass of larvae cultured on HF-fumigated plants reflected a delay in development as well as a reduced growth. Larvae from the eggs laid by beetles cultured on HF-fumigated tissue pupa-

ted and enclosed three to six days later than controls, and the adults commenced reproductive activity with the same lag in time. Beetles cultured on the fumigated plants also contained greater amounts of fluoride than the controls, and the fluoride content of females was greater than that of males orboth HF-fumigated and control plants. Beetles raised on fumigated plants laid fewer egg masses and fewer eggs per mass, although when the first generation was repeated at a later date there was no significant effect. Feeding activity was reduced in both larval and adult stages in beetles cultured on the fumigated plants, and adults showed less flight activity than controls. A difference in color of the elytra was also noted; beetles on HF-fumigated plants were paler than controls.
Source: 1

#948
Weinstock, B. "Carbon monoxide: Residence time in the atmosphere." Science, 166:224-225 (1969).

A lower limit of 0.1 year for the residence time of carbon monoxide in the atmosphere is derived from radiocarbon measurements. The action of certain microorganisms and atmospheric photochemical reactions are possible mechanisms for the removal of carbon monoxide. The value can be compared with 2.7 years, a value deduced from estimated rates of carbon monoxide production and global measurements of atmospheric concentrations of carbon monoxide.
Source: 5

#947
Weinstock, B. and H. Niki. "Carbon monoxide balance in nature." Science, 176:290 (1972).

Consideration of the steady-state equations for stable carbon monoxide and for radioactive carbon monoxide in the troposphere leads to the conclusion that carbon monoxide is produced at a rate of 5×10^{15} grams per year, a value some 25 times greater than the rate of carbon monoxide production from combustion. The concomitant residence time for carbon monoxide is 0.1 year, in agreement with a previous estimate of Weinstock. Hydroxyl radicals are shown to account for both the production of the large amount of carbon monoxide by methane oxidation and for its removal by carbon monoxide oxidation. The average concentration of hydroxyl radicals in the troposphere required to achieve this effect is 2.3×10^{6} molecules per cubic centimeter, with a daytime concentration of twice that. Levy and McConnell, McElroy and Wofsy have deduced concentrations of hydroxyl radicals in the troposphere of the same magnitude from purely photochemical considerations, in support of this model.
Source: 5

#1828

Weintraub, R.L., and L. Price. "Inhibition of plant growth by emanations from oils, varnishes, and woods." Smithson. Misc. Collect., 107(17):1-13 (1948).

The inhibition of plant growth by emanations from oils, varnishes, and woods is discussed. Air in contact with certain oils, varnishes, and woods acquires the property of inhibiting or markedly retarding the germination of oats, wheat, and corn, and also, to less pronounced degree, sorghum, barley, tomato, bean, lettuce, and radish. The inhibition or retardation ceases completely on removal of the seeds from the affected air. Since the active agent could be transferred in an air stream from one container to another, it is considered to be of the nature of a chemical vapor rather than some form of radiant energy. The volatile products of autoxidation of unsaturated fast include carbon dioxide, carbon monoxide, organic acids, aldehydes, and peroxides. These substances were tested for inhibitory properties. The more active compounds were some organic acids, H_2O_2 and acrolein.
Source: 1

#1604

Weisser. Forests as natural protection barriers against air pollution between adjacent industrial and residential areas. Preprint. Translated from German by Edith R. Johnson, 9 p. (1961).

Forests and even small parks play an important role as air cleaning agents. Air traveling through the sieve-like mass of foliage is filtered by the many surfaces of branches, leaves, needles, and hairs, and particulates are caught and held. This material is washed to the ground by the next strong rain, preparing the foliage for further filtering. In addition, dust-carrying winds passing through the forested area are slowed, causing the dust to settle out. It is estimated that 2-1/2 acres of spruce can hold about 32 tons of dust and a similar area of beech, 45 tons. Vegetation plays a critical role in the oxygen-carbon cycle of human and animal respiration by taking up CO_2 and oxygen from the atmosphere and returning oxygen; it also refills the CO_2 supply through the microbiotic decomposition of organic material. When the air taken in by vegetation is polluted, it is detoxified at the cost of deleterious effects of the pollutants on the plants. A circumferential urban green belt is important in providing sources of cool air to replace warmed city air, permitting the latter to rise and diffuse. Needled trees suffer more severely from smoke damage than leaved trees; the fir is the most susceptible, followed by spruce, various species of pines, and larch. Oaks, alders, birches, beeches, and maples are among the more resistant leaved varieties. Therefore, forest management policies in heavily smoke-damaged areas aim toward replacing injured needled trees with leaved wood, both to preserve the health of the forest and to help in whatever degree possible in lessening atmospheric pollution.
Source: 1

#126

Weisser, D. "Woods as natural barrier against air pollution in areas of concentrated industrialization and urbanization." Wasser Luft u. Betrieb, 5:96-8 (March 1961).

Woods and parks have an exceptional position in the control of contamination of the air. The filtering effect of foliage and needles reduces dust and detoxicated the air of the industrial waste gases by causing turbulence and deviation of the airflow. The air in a wooded area is a decisive factor in the oxygen-carbon dioxide cycle which is indispensable for the welfare of man, animal, and plans. Such a wooded area feeds a continuing stream of fresh air, with a high percentage of oxygen, into the air dome pressing upon the concentrated areas of industrialization and urbanization. On the other hand, the woods themselves are subject to the influence of noxious emissions from industrial areas. Conifers have been found to be more susceptible to toxic emissions than are deciduous trees. Therefore, there has been a trend for some time to change to the deciduous types in those trees making up such a wooded barrier. (LC)
Source: 6, 7

#713

Wellburn, A.R., O. Majernik, and F.A.M. Wellburn. "Effects of SO2 and NO2 polluted air upon the ultrastructure of chloroplasts." Environ. Pollut., 3(1):37-49 (Jan. 1972).

The ultrastructure of mature bean tissue exposed to air polluted by various concentrations of sulfur dioxide or nitrogen dioxide at a maximum stomatal aperture for short periods was compared with similar unpolluted tissue, using an electron microscope. Both pollutants caused swelling of the thylakoids within the chloroplasts, but no extra chloroplastidic damage was directed. The thylakoid swelling could be reversed by removing the pollutant from the air flow or changing the rate of gas flow within the tissue. The phenomenon is discussed in relation to previously reported dimunution in the rate of photosynthesis when higher plants are exposed to either sulfur dioxide or nitrogen dioxide.
Source: 1

#714

Wells, A.E. "Fumigation experiments to determine the effect of highly diluted sulphur dioxide on a growing grain crop." Bull. Bureau Mines, 98:213-307, 503-520 (1915).

Following complaints of damage to crops and orchards within the Selby smoke zone, experiments were undertaken to determine the visible injury to growing barley plants brought about by fumigation with definite concentrations of sulfur dioxide and for definit times; the effect of visible injury on crop yield; and the possibility of invisible injury. A continuous 3 hour fumigation with 3 ppm, or more, of SO2 caused visible bleaching on barley plants in Vallejo and Davis when plants were less than 15 cm high. Injury was great at 5 ppm SO2, more than 2/3 of the foliage was bleached. The injury produced was principally the concentrated or kill-back type. Severe bleaching was also caused by long-time fumigation with as little as 1 ppm SO2. The bleach developed most rapidly in the sunlight. Repeated five-minute fumigations with 3-5 ppm SO2 markedly reduced grain yield. Yields were lower following 186 5-minute fumigations with 4 and 5 ppm SO2 than following 90 10-minute fumigations at the same concentrations. Plants fumigated with 1 or 2 ppm SO2 did not show reduced yeild.
Source: 1

#248
Wells, A. E. "Results of recent investigations of the smelter smoke problem." (Presented at the Symposium on the Chemistry and Metallurgy of Zinc, American Chemical Society Meeting, 54th, Kansas City, April 12, 1971.) J. Ind. Eng. Chem., 9(7):640-646 (July 1971).

Recent investigations have shown that smelter emissions of dust and metallic fumes are of minor importance in causing damage to nearby vegetation, although they do have significant livestock effects. The most important problem concerns sulfur dioxide. At many plants where large quantities of sulfide ores are handled, serious efforts are being made to utilize waste SO2 through the manufacture of sulfuric acid, liquid SO2 and elemental sulfur. It is necessary to determine the effects, in regard both to superficial bleaching and to economic results on yield, of applying various concentrations of SO2 to various forms of plant life and under different atmospheric conditions. Fumigation tests demonstrate that under certain atmospheric conditions, bleaching of crops, especially grains, can be produced by very small concentration of SO2 if the time of application is sufficiently long. Visible bleaching on grain, if endured during the early stages of growth, does not necessarily affect the ultimate yield. Determinations of bleaching conditions, influence of weather conditions, and determination of SO2 in air are discussed. At zinc plants in the natural gas belt, roaster stack temperatures are very high, about 350 to 400 C. Where the temperatures are lower (150 to 200 C), the gas concentrations are also very low, less than 0.3% SO2.
Source: 1

#78
Went, F. W. "Blue hazes in the atmosphere." Nature, 187:641-643 (1960).

Discusses the phenomenon of blue haze found over large forestal areas, e. g. Smoky Mountains, Blue Ridge Mountains. Suggests that utilization of terpenes and other plant products results in the blue haze. These products accumulate and condense at the alto- and stratocumulus cloud interface to form veil clouds. The size of the particles in veil clouds may be effective condensation nuclei. These particles, composed of bituminous and asphaltic materials are rained down attaching to soil particles or organic matter and are, perhaps, the source materials for petroleum deposits or the basis of much of the heat content of coal.
Source: 7

#715
Went, Frits, W. "Plants monitor air pollution." Sci. Citizen, 7(10):6-9 (Oct 1965).

The effects of photochemical smog on plants and the use of plants as indicators of air pollution are discussed. Experiments have shown that there are at least two effects of smog which do not give any immediately visible symptoms. One is a general growth retardation. This was shown only in seedlings; it is not certain whether mature plants also show this. The second effect is a closing of the stomata of the

leaf,which will decrease the rate of photosynthesis. Plants are more sensitive to smog than animals or humans, and can be used as a warning devices. When signs of damage begin to appear in plants, concentrations of air pollutants which may be poisonous to animals and man are being approached. If the lower surface of spinach, beet, or swiss chard leaves show a silvery or bronzed appearance, the leaves of annual blue grass show white banding, or petunia leaves show white discolored areas, photochemical smog is indicated as cause for the damage. By observing which leaves show this damage, the date when the smog was present can be approximated, since the leaves are most sensitive during the period of expansive growth. If the leaves show a general ivory-white bleaching, or bleaching between the veins, the toxicant was probably sulfur dioxide. A brown burn around leaf edges, spotting on corn leaves, or white or yellow discoloration of the tips of gladioli indicates the presence of hydrofluoric acid. Plants in cities can constitute a vast air pollution monitoring network if many more persons are trained in the recognition of plant damage and sent throughout the country to monitor toxic air conditions.
Source: 1

#272
Went, F.W. "Natural air pollution." Air Pollution, 28/29: (Suppl.) 19-20 (March 1972).

Vegetation releases at least 1000 million tons of olefin-like compounds, mainly terpenes, which like olefins can undergo transformation into a natural blue haze. The simplest method for measuring this photochemical transformation of terpenes is to determine the formation of Aitken condensation nuclei (ACN). These are submicroscopic particles on which water droplets condense in air supersaturated with water vapor. The number of ACN rises from a nighttime low of 1000-2000 ACN/cc to 10 times this number later in the day for pure country air and can vary from 10,000 in the morning to 100,000-1,000,000 in the afternoon for cities. Thus, there is a diurnal cycle of Aitken nuclei production wherever organic volatile substances get into the air. The ACN diffract more and more light as they grow in size and thus produce a blue haze, behaving exactly like photochemical smog in this respect. Thunderstorms often clear the air of this haze; and by collecting rainwater, a remarkable amount of dirt, usually dark-grey in color, can be found. A study of how this natural air pollution is dealt with by nature and is removed by natural processes will be most useful in dealing with man-made air pollution.
Source: 1

#249

Wentzel, K. F. "Zur Bodenbeeinflussung durch industrielle Luftverunreinigungen und Duengung in Rauchschadenslagen, insbesondere mit Kalk." (The effects of industrial air pollutants and time fertilizers on smoke-exposed grounds). Text in German. (Presented at the Bezirksgruppentagung des Buodes Deutscher Forstmaenner, Muenster, West Germany, Jan. 22,1959.) Forst-Holzwirtschaft, 14(8):178-182 (1951).

While air is only a temporary carrier of industrial pollutants, the soil is the final site of their absorption. Sulfur dioxide and fluorine compounds are the main smoke constituents and metal oxides and silicic acid are the main dust constituents absorbed by soil. Sulfur dioxide containing smoke elicits an acid pH. Conversion of SO2 into sulfurous or sulfuric acid which is then conveyed into the ground by rain or snow increases soil acidity. The available free bases of the soil are then converted into insoluble sulfates, depriving the plants of an important nutritional requirement. Forest are the most susceptible to damage from smoke because of their poor buffering properties and their initial low base contents. Metallurgical processing, cement, and electric power producing plants are the main dust emission sources. Dusts may elicit acid, neutral, or alkaline pH, according to their chemical composition. Dust fall inflicts severe damage to soil structure. Application of fertilizers such as lime would prevent the acidifying effects from smokes and would improve plant resistance against noxious agents. Fertilizer application would also provide a means for the protection of soil structure.
Source: 1

#1225

Wentzel, K.F. "Rauchschadenkundliche Lehren der Untersuchung von Wirkungen eines Ausfalles von Filter-und Absorptionsanlagen einer Bleihütte." (Smoke damage to forests resulting from the breakdown of filtering and absorption devices on a lead smeltery). Wiss. Z. Techn. Univers. Dresden (Herausgeber: Der Rektor), 11(3):581-588 (1962).

Air pollution from smelteries in the Jaxon Mountains (Erzgebirge) led to scientific research in forest smoke damage 100 years ago. Today this field (started by scientists in Tharandt) has gained world wide significance. But despite all technical progress, study of air pollution and its damaging effects still shows an alarming disproportion between an increase of damaging emissions, and inadequate means to stop or neutralize emissions from the air pollution sources. Forest areas lying in the plumb area of a West German lead smeltery were examined. The studies have shown that the success of forestal air pollution damage diagnosis depends on the selection of a proper combination of several methods. The determination of damages should include suggestions for prevention, or at least, mitigation. Even under favorable circumstances, it is the rule that mitigation can only reduce the intensity of this damage because no forest tree species is absolutely air pollution resistant.
Source: 6

#1229
Wentzel, K.F. "Waldbauliche Massnahmen gegen Immissionen." (Forestal measures to counteract the effects of emissions). Allgemeine Forstzeitschrift, 7(18): 101-106 (1963).

The measures most used in forestry to reduce damage caused by emissions are described in this article. Changing to more smoke resistant trees has become the most widely used method. In many cases it has become necessary to change the stock of wide forest areas. However, it is sometimes possible to avoid this radical measure by forming so-called smoke-barriers. This means that a band of leaf trees is planted in front of the conifers for protection. Another important measure is the improvement of growing conditions, especially by fertilization. Lastly, it has become essential to select seedlings of smoke resistant species.
Source: 6

#1203
Wentzel, K. F. "Are there immission-proof or smoke resistant trees." Forestry Archivs, 35(3):49-51 (1964).

Immission resistance is not a characteristic which a tree possesses or does not possess. Plants do not possess an absolute resistance or even a disposition to resistance to immission. There are only relative degrees of resistance of various plants to various pollutants at different developmental stages of plants. A general rule applies, namely, that planting of conifers should be avoided where high immission levels prevail and deciduous trees should be planted instead. Of conifers and of deciduous trees, slow-growing species are more pollution resistant while species with a high assimilation capacity are less pollution resistant. Fertilization can to some degree counteract the harmful effect of pollutants on trees. Aside from grasses and other annual or short-lived culture plants, low bushes resist immissions best and longest. The lower the immission, the wider the choice of tree species that can be planted, including evergreens. In transition belts to lower immission levels, the relatively pollution resistant species like thuja, Chamaecyparis, and black pine can be grown successfully. Picea and Abies can be grown only at very low immission levels.
Source: 6

#1825
Wentzel, K.F. "Gibt es immissionsfeste oder rauchharte Baeume." (Are there immission-proof or smoke resistant trees?). Forstarchiv, 35(3):49-51 (1964).

Emission resistance is not a characteristic which a tree possesses or does not possess. Plants do not possess an absolute resistance or even a disposition to resistance to emissions. There are only relative degrees of resistance of various plants to various pollutants at different developmental stages of plants. A general rule applies namely that the planting of conifers should be avoided where high emission levels prevail and deciduous

trees should be planted instead. Of conifers and of deciduous trees, slow-growing species are more pollution resistant while species with a high assimilation capacity are less pollution resistant. Fertilization can counteract to some degree the harmful effect of pollutants on trees. Aside from grasses and other annual or short-lived culture plants, low bushes resist emissions best and longest. The lower the emission, the wider the choice of tree species that can be planted, including evergreens. In transition belts to lower emission levels, the relatively pollution resistant species like Thuja, Chamaecyparis, and black pine can be grown successfully. Picea and Abies can be grown only at very low emission levels.
Source: 1

#1231

Wentzel, K.F. "Erfahrungen bei der Bearbeitung Forstlicher Immissionsschaeden in Deutschland." (Experiences in dealing with smoke damage of forests in Germany). Mitteilungen der Forstlichen Bundes-Versuchsanstalt Mariabrunn, 73:237-247 (1965).

This speech, given in Austria, reports on experiences with smoke damage caused by increasing industrialization. It points out the topics that should be considered when a new Austrian law will be formulated: In forestry, emissions have become a factor in local conditions, just as climate and soil; Individual house heating causes no significant damage, but SO_2 and HF in high concentration do; Concentration of toxic gases varies over time. Usually it is the short peak concentration that causes the damage; To evaluate the damage, it is necessary to examine the plants. Analysis of the air can only show possible endangerment; and Measures against damage such as selection of smoke resistant trees.
Source: 6

#1204

Wentzel, K. F. "Landscape protection against immissions." A lecture at the Botanists' Convention in Bonn, September 9, 1965. Applied Bot., 40(½):1-11 (1966).

Experiments were done on various plant by exposing them to certain elements such as SO_2 or HF in an air mixture, and then, find out the extent of damage to the plants caused by these gasing tests. The gasing experiments are essential in regards "to reproducing symptoms of damage, for ascertaining threshold values of degrees of damage on the basis of concentration and space of time and for investigating critical phases of growth." The gasing tests can be "utilized to investigate the differences in resistance of plants that have been exposed for the same lengths of time and that are of comparable age or growing period." Comparations of the resistance to smoke immissions of conifer and deciduous trees are drawn. The geographical range of immission damage of significant effect is discussed . Examples of the extent of damage also are given. The author writes about various contributors to air pollution and discusses some methods for reducing air pollution. These include technological protective measures, land planning measures, and botanical measures.
Source: 6

#1202
Wentzel, K. F. "Methods in treating forest immission damages in Germany." Mitterlungen der Forstlichen Bundes-Versuchsanstalt Mariabrum 73:237-247 (1966).

Immission damages were observed of forests in Germany after the industry was destroyed by war. As the air became clearer, trees were greener and growth ring width was increased. Most immission damage to trees occurs with highly concentrated industrial pollution. Traffic and domestic fuel consumption causes only minimal pollution damage in Germany. (In U. S., there is the problem of photochemical air pollution). There is no uniform concentration of aerosols over time, thus much aerological data must be measured before accurate prediction of damages from pollution can be formulated. Atmospheric analysis may prove a threat to vegetation, but can't prove damage. Foliar analysis supplies cleaner results from coniferous trees than from decidious trees. Coniferous forests are more susceptible to pollution. The author contradicts findings of exposure experiments as sufficient basis for establishing a sensitivity index to plants. In addition, means for preventing immission damages are discussed, as well as the importance of forests.
Source: 6

#1954
Wentzel, K.F. "Prestebni zmirnujici prostedky proti imism." (Sylvicultural measures for reducing the effects of emissions). Scientific and Technical Society, Prague (Czechoslovakia), Agricultural and Forestry Section, Proc. Conf. Effect Ind.Emissions Forestry, Janske Lazne, Czechoslovakia, p.XII-1 to XII-13 (Oct 11-14, 1966).

The smoke damage to forests is an acute research problem in Central Europe. The area of substantially damaged conifer forests is approximately 300,000 ha. Since these are mostly forest stands with planned and predetermined fixed net yields, the local forestry enterprises and staff face a special responsibility. They must act rapidly and correctly, even if they are unable to prognosticate future developments. Their task is frequently unsolvable. Among the measures that may be used to adapt forests to emissions are the following: conversion to stands which are resistant to smoke, establishment of protective strips, preventive measures with respect to the exploitation of lumber, and improvements in growth conditions. These sylvicultural measures were briefly discussed. Truly effective protection of forests is possible only with the aid of industry itself.
Source: 1

#1824
Wentzel, K.F. "Bedeutung, Aussichten und Grenzen der Zuechtung relativ rauchharter Baumsorten im Lichte immissionsoekologischer Erfahrungen in Mitteleuropa." (Significance, prospects and limits of breeding smoke-resistant tree species in the light of central European studies on the ecological effects of fumes). Proc. Congr. Intern. Union Forest Research Organizations, 14th, Munich, West Germany, 5(24):536-555 (196?).

Damage to tree stands in central Europe from atmospheric pollution will become more extensive with time; thus, the breeding of pollution-resistant tree species assumes increasing importance. Since no differences in resistance could be detected in individual pine trees by experiments, interest focussed on spruce trees where such differences exist and were proven. But no spruce specimens were ever found which in resistance would have surpassed deciduous trees, whose regenerative power is a factor governing their considerable resistance to damage from pollution. Resistant spruce specimens were found to have comparatively massive needles, which also applies to other species of conifers. Thus there seems to be a connection between the anatomical structure of the needles and their degree of hardiness in a polluted atmosphere. Breeding of relatively resistant spruce trees by selection was started in 1956 and the first planting experiments in polluted areas were carried out in 1960. This work is of great importance for the reforestation of approximately 100,000 hectares of forests in central Europe.
Source: 1

#1826
Wentzel, K. F. "Die Immissionresistenz der Pflanzen." (The pollution resistance of plants.). Translated from German. Translation Consultants, Inc., Arlington, Va. Baum-Ztg., 2(3):42 (1968).

Combinations of pollutants and various periods of exposure exist for each plant, the influence of which can cause the plant to wither or die. Just as in any other toxic reaction, the effect depends upon the dosage that interferes with assimilation. Individual plants endure degrees of pollution depending upon type of emission, development phase of the plant, growth conditions, and orographic situation. Criteria for evaluating emission resistance experimentally and in open air are discussed. Lists of plants ranging from the least to the most sensitive apply only to the particular conditions of pollutions, exposure, growth, location, and plant development, for which they were determined.
Source: 1

#1823
Wentzel, K.F. "Empfindlichkeit und Resistenzunterschiede der Pflanzen gegenueber Luftverunreinigung." (Sensitivity and differences in resistance of plants to pollution). Forstarchiv, 39(9):189-194 (Sept 1968).

Until 1940 the SO2 concentration threshold beyond which damage to vegetation could be expected was considered to be 2 ppm. Recent experiments in chambers with controlled atmosphere show that the true threshhold is around 0.2 ppm; and field experiments show that the most sensitive plants manifest deleterious effects from a median long-term exposure level of 0.02 ppm SO2. The sensitivity thresholds for hydrogen fluoride are even lower. These data help explain the wide extent of emmission damage in old coniferous stand as well as the occurrence of such damage at distances 10-30 km from the source. The resistance of plants to pollution varies with a whole complex of factors, primarily with type of emission, growth conditions, the developmental stage of the plants, and nature of the exposure. The combination of these factors will govern the difference of a plant species. A distinction

must be drawn between experimental and field resistance, the former judged by leaf sensitivity, the latter by livability and yield impairement. No sequence of plants can be compiled in their order of resistance that would be valid under all conditions. Generally, the danger to vegetation from pollution increases in the order of cereal crops, deciduous trees, horticultural crops, fruit trees, fodder crops, ornamental plants, and conifers.
Source: 1

#1827
Wentzel, K. F. "Habitus-Anderung der Waldbaeum durch Luftverunreinigung." (Habit Changes in forest trees due to air pollution). Translated from German. (Presented at the IUFRO Congress,15th, Gainesville, Fla., March 1971.) Forstarch IV, 42(8-9):165-172 (1971).

Many years of chronic pollution may cause considerable changes in the needles or foliage and, as time goes on, also to the crown and truck shapes of individual trees as well as entire forest stands. Shearing of crowns by pollutants, diminution of longitudinal growth and truck deformations are discussed, including research near a local zinc foundry shut down in 1930 and research results from the Ruhr region. Tree crowns in the vicinity of pollution sources experience asymmetrical deformations, due to a decline in germinative power primarily on the sides facing the emissions of exhaust gases. Pine stands in the Ruhr Valley have tolerated for more than 70 years, maximum air pollution levels corresponding to a decline of the longitudinal growth to about one-third of the growth potential, the radial growth to about one-half, and overall productivity to about one-tenth.
Source: 1

#543
Wentzel, K.F. "Salzstaub- und Salzspritzwasserschaden an Strassenraendern." (Damage alongside highways caused by salt-dust and salt-water). Der Forst- und Holzwirt, 28(22):445-449 (Nov. 25, 1973).

Salt used to de-ice highways is becoming a new danger to the environment. Unlike sand or gravel, salt is not redistributed by moving vehicles, and is therefore used almost exclusively on today's highways. Up to 61.5 tons per year of salt have been put on 1 km of the German Autobahn (4 lane highway); the average amount in the Winter 1969/70 was 33 tons per km. This causes extensive damage to cars and roads. The groundwater is affected (change in pH - value), and of more importance, the vegetation alongside highways is seriously threatened. Young trees, planted close to the road, have no chance to develop and pine stands are affected by the salt within a range of 50 m. Various quantitative methods are described to determine the absorption of salt by plants. It is finally demanded that environmentally safe methods to de-ice highways be developed.
Source: 2

#1230
Wentzel, K.F. and B. Ohnesorge. "Zum Auftreten von Schadinsekten bei Luftverunreinigung." (The proliferations of a harmful insect resulting from air pollution). Forstarchiv (Druck: Gebr. Gerstenberg, Hildesheim), 32(9):177-186 (Sept. 15, 1961).

A tremendous increase in the population of the small pine leaf wasp (Pristiphora abietina), distant from its usual breeding area, was detected around a charcoal plant near Bodenfelde (Weser). Using atmospheric, biochemical, and entomological tests, an attempt was made to find a correlation between the air pollution and the insect distribution. The available methods were sufficient to prove the existence of this correlation, but it was not possible to find the exact scientific causes. Observation of the insect (and its parasites) and the host plant showed that the degree of parasitism of the cocoons was significantly decreased the closer to the smoke source. Changes were also seen in the components of the leaves. These changes were caused by "invisible" physiological influences, which could have altered the conditions in the pine stands, and made them susceptible to the infestation by the wasps (the wasps not being considered a primary parasite). Just a small amount of smoke emission is likely to cause an increase in parasitism of white pines by Phistiphora abietina.
Source: 6

#49
Westberg, H. H., and R. H. Rasmussen. "Atmopsheric photochemical reactivity of monoterpene hydrocarbons." Chemosphere 4:163-168 (1972).

The reactivity of terpenes in the presence of nitrogen oxides and light, consisting of wave lengths characteristic of natural sunlight, was studied. Reactivity increased in the order saturated < aromatic < olefinic; within the latter group increased substitution of double bonds facilitated reaction. Observed reactivity trends implicated an electrophilic attacking species. The low rural concentrations of olefinic hydrocarbons and the results of this study indicate that those hydrocarbons released by plants have a low residiual time. Products of the reactions of these compounds should be studied since they should be plentiful constituents of natural forest air.
Source: 7

#716
Westlake, D.W.S., J.M. Roxburgh and G. Talbot. "Microbial production of carbon monoxide from flavonoids." Nature(London), 189(4763):510-511 (February 11, 1961).

Flavonoid compounds are a potential source for carbon monoxide production by molds. Aspergillus flavus degrades rutin to protocatechuic acid, phloroglucinol carboxylic acid, rutinose, and carbon monoxide, the last named being derived from carbon 3 of the flavonoid molecule. The extent of distribution of this degradative pathway in microorganisms and the structural requirements for the production of carbon monoxide were determined by comparing the amount of carbon monoxide produced after the growth of microorganisms on various flavonoid compounds. A hydroxyl group in the 3 position is required for carbon 3 to be released as carbon monoxide.
Source: 1

#1822
Wettig, K. L., M. Schabad, and A. J. Chesina. "Bestimmung von 3,4-Benzpyren in Pflanzensamen vor und nach Keimung." [Determination of 3,4-Benzopyrene in plant seeds before and after germination]. Z. Ges. Hyg. Ihre Grenzgebiete (Berlin), 18(12):933-934 (1972).

The determination of the maximum allowable emission concentration is increasingly based on the extent of the various emissions in the human environment. In the case of carcinogenic pollutants, the concentration zero has been recommended by many as the maximum allowable concentration. A good argument against this opinion was the discovery of the natural endogeneous synthesis of polycyclic hydrocarbons by plants and microorganisms. In this connection, the natural 3,4- benzopyrene concentration of the following plant seeds was studied: bean, pea, dill, spinach, cress, and lupine. Under the experimental conditions no endogeneous synthesis of 3,4-benzopyrene took place at the germination process. A 3,4-benzopyrene formation from the organic substance of the seeds did not take place. The experiments revealed that the seeds produce benzopyrene solely from the nutritive substance. Benzopyrene was also found in plant seeds which had not yet been analyzed by anybody before. To what extent the 3,4-benzopyrene concentration stemmed from sedimented air pollutants or from the soil depended greatly on the air pollution in the area the plant grew. No food plants should be grown in heavily air polluted areas.
Source: 1

#1850
Wheeler, G. L. "The effects of fluorine on the cycling of calcium, magnesium, and potassium in pine plantations of eastern North Carolina." North Carolina State Univ., Raleigh, Dept. of Botany. Ann Arbor, Mich. Univ. Microfilms, Inc. 72 p. (1972).

The effect of fluorine emissions from ore processing plants in some ecosystems, with respect to the points of accumulation and the effects on the cycling rates of calcium, magnesium, and potassium, was investigated in North Carolina pine plantations. The only visible damage occurred during the late winter and early spring and was characterized by a visible browning or necrosis of needles. Fluorine was associated with an increase in the return rate of Ca and K through leaf leaching and of all three nutrients, Ca, K, and Mg, by increasing the contents of litterfall. The Ca content of the litterfall increased with increasing F content. There was no detectable relationship between F or the three nutrients and net primary production. The sites of accumulation of F were in the needles, litter, and soil. The trees accumulated the greatest amount of Ca, followed by K and Mg in that order.
Source: 1

1598
Whelpdale, D.M. "The contribution made by air-borne pollutants to the pollution of large bodies of water." Atmosphere, 10(1):18-22 (1972).

The pollution of large bodies of water by airborne pollutants is discussed. Twenty-five percent of pesticides and 50% of heavy metals such as lead reaching the oceans are contributed by atmospheric sources. The chemical composition and low buffering capacity of freshwater bodies makes them susceptible to more potential pollutants such as sulfur dioxide, nitrogen, and phosphorus. Pollutants enter the water directly from precipitation scavenging and dry deposition or indirectly from surface run-off and ground-water. The scarcity of direct measurements of atmospheric pollutants contributions to the pollution of large bodies makes it difficult to establish pollutant budgets for specific substances and specific bodies of water. The Canadian Atmospheric Environment Service is investigating airborne pollution of water including the measurement of vertical fluxes of ozone, carbon dioxide, and sulfur dioxide of a lake.
Source: 1

#1606
Whelpdale, D.M. "Particulate residence times." Water, Air, Soil Pollut., 3(3):293-300 (Sept. 1974).

Examination of suspended particulate concentration data from a year-long, regional air quality study of a portion of the Great Lakes area revealed that depletion of particulates occurred during extended periods of travel over water surfaces. Based on particulate concentrations and meteorological measurements, residence times of background regional particulate matter were between 5 and 16 hr in the region. Using a simple model for the deposition of particulate matter into the lakes, deposition rates ranging from 0.2 to 3.9 micrograms/59 m/sec were found. This results, for example, in an estimated 150 metric tons of material being deposited into Lake St. Clair, with an area of 1270 sq km, during a 24-hour period.
Source: 1

#144
White, E. J., and F. Turner. "A method of estimating income of nutrients in a catch of airborne particles by a woodland canopy." J. Applied Ecology 7: 441-461 (1970).

A method is described to estimate income of potassium, magnesium, calcium, phosphorus and sodium to a woodland ecosystem in catch of airborne particles by the tree canopy. Catch at mean canopy height was sampled continuously in natural air-flow impactors which were changed monthly. Comparisons were carried out in the field of catch by the impactors and catch on leaves and branches using artificially-generated aerosols of NaCL solution. Data were available of dry weight of branches and the number of leaves per hectare, and variation in leaf size during the season was sampled. Income of nutrients per hectare per month was estimated by combining the data. Income in some elements appeared greater than in rainfall over the same period. The method was based on assumptions which are discussed. Over-estimation was thought to have occurred, especially in windy months. Estimated mean velocity of deposition for the elements examined varied from 3.0 to 7.1 cm/sec.
Source: 6, 7

#1867

Wieler. "Die Grenzkonzentration fuer die Schaedigung der Vegetation durch schwefelige saeure." (Threshold concentrations of sulfurous acid for plant damage). Z. Pflanzenkrankh. Pflanzenschutz, 28:97-105 (1918).

The problem of the applicability of studies carried out under laboratory conditions to those of the field is discussed and illustrated. Tree species have been exposed to smoke, including various concentrations of sulfur dioxide in a greenhouse. A 20 ppm SO_2 concentration limit was established for the most sensitive ordinary spruce species using needle browning as a criterion. Air sample analysis carried out at 1200 m and 2400 m from an industrial source disclosed considerably high SO_2 concentrations, which appeared to be harmless to the surrounding forests. The error in setting the allowable concentration at 20 ppm consisted in the neglect of a temperature factor. In a greenhouse exposed to light radiation, part of the radiation is absorbed by the chloroplasts for photosynthesis needs, while the excess light radiation is converted into heat. Thus, the tree leaves or needles must have reached temperatures exceeding by far the controlled temperature of the secluded environment. The free air conditions differ due to air mobility which helps the maintenance of the plant temperature balance through perspiration on account of the continuous air flows or other heat transfer processes. A study should be made to see whether the chronic smoke damage is actually a temperature effect or whether increased temperatures enhance plant cell susceptibility towards SO_2.
Source: 1

#1821

Wilhour, Raymond G. "The influence of ozone on white ash (Fraxinus americana L.)." Pennsylvania State Univ., University Park, Dept. of Plant Pathology, Thesis (Ph.D.), 86 p. (Dec 1970).

Scattered stippling of the upper leaf surface was the most common symptom of injury to white ash (Fraxinus americana L.) seedlings exposed to 10 and 25 ppm ozone for various time intervals ; in fewer cases, stipples were confined to specific areas of the leaf. Bifacial necrosis and tissue collapse were less common symptoms. Seedlings one-year-old were sensitive to 10 pphm ozone for 0.5 hr or 25 pphm for one hr. A direct relationship was present between and exposure time to 25 pphm ozone for exposures of one to five hr; sensitivity remained relatively constant at longer exposures up to eight hr. Seedlings treated with a high temperature before or after exposure were more sensitive than those treated at a lower temperature. In contrast, seedlings exposed to ozone at a low temperature were more sensitive than those exposed at a higher temperature. Seedlings treated with a high relative humidity before, during, or after exposure appeared to be more sensitive than those treated similarly but a lower relative humidity. However, the difference in sensitivity was significant only when the relative humidity treatments were made prior to exposure. An additional factor, nutrient level, was also important in governing sensitivity. Fertilization significantly increased the sensitivity of three-year-old seedlings to ozone. White ash seedlings were sensitive to 25 pphm ozone during the 15 week period of the growing season examined. Sensitivity increased initia-ly with age, but after a maximum level of sensitivity was reached it remained relatively constant for the duration of the growing season. Cotyledons, primary leaves, and secondary leaves appeared to respond to ozone in a similar manner.
Source: 1

#284
Wilkniss, P.E., R.A. Lamontagne, R.E. Larson, J.W. Swinnerton, C.R. Dickson, and T. Thompson. "Atmospheric trace gases in southern hemisphere." Nature Phys. Sci., 235(142):45-47 (Sept. 17, 1973).

Five trace gases: carbon monoxide, carbon tetrachloride, freon II, methane, and radon were measured in the atmosphere over the North and South Pacific and the ice covered Ross Sea. Measurements were taken in Nov and Dec 1972. In the northern hemisphere, CH4 levels were slightly higher and the CO concentrations definitely exceeded those of the southern hemisphere by a factor of four. The hypothesis that CO is formed in the atmosphere by the oxidation of CH4 was not supported, since the CO levels dropped considerably in the southern hemisphere although methane values remained constant. Carbon tetrachloride showed a nearly uniform global distribution due to its probably overwhelming production by natural sources. There are no natural sources for freon, but it was present in the northern hemisphere due to industrial production. The Rn values were high in the northern hemisphere near the North American continent and decreased to levels below 1 PCim to the -3rd power near the equator. Radon levels remained low until several peaks appeared between 30 and 40 deg S where low pressure systems originating over and around Australia carried continent air across the track of Galcier. High Rn concentrations were also evident near New Zealand. From New Zealand to McMurdo Station is the Antarctic, Rn had low concentrations until two peaks were observed on Dec. 23 and 25 when the ship was near McMurdo.
Source: 1

#378
Will, J. B., and J. M. Skelly. "The use of fertilizer to alleviate air pollution damage to white pine (Pinus strobus) Christmas trees." Plant Disease Reptr., 58(2):150-154 (Feb. 1974).

The use of fertilizer to alleviate air pollution damage to white pine (Pinus strobus) Christmas trees was investigated over a 2-year period. Elimination of air pollution symptoms on Christmas trees is feasible through the use of a high nitrogen fertilizer. Fall application of 25-9-9 fertilizer reduced symptoms expressed as a burning or yellowing of the new needles. Four rates (1-4 cups, 8 oz each) were applied to trees of various heights, and a recommendation of rates based upon tree heights and symptoms was developed.
Source: 1, 2

#717
Williams, C. "The accumulation of lead in soils and herbage at Rothamsted Experimental Station." J. Agr. Sci., 82(1):189-192 (Feb. 1974).

To measure the accumulation of lead in an area 42 km from London and within 2 km of the A5, A6, and M1 trunk roads, the Pb contents of topsoils collected from sites at Rothamsted Experimental Station since 1881 have been deter-

mined. From 1883 to 1972 the increases ranged from 17 to 46% but because of the variable Pb contents within fields, the absolute rate of accumulation is difficult to determine. The Pb content of herbage harvested twice yearly since 1920 has not increased noticeably. The Pb contents of the herbage samples did not reflect the introduction of antiknock additives (tetraethyl Pb) to gasoline, in the 1930s, or to increased motor traffic. Increases in the Pb content of the herbage were reflected by increased titanium contents, and may therefore have arisen from contamination by dust. The effect is more noticeable in the second harvest, but it cannot be related in any way to motor traffic, as it is equally apparent in both the 1920-23 and 1972 samples.
Source: 1

#554
Williams, J.D., J.R. Farmer and R.B. Stephenson. "Air pollutant emissions related to land area - a basis for a preventive air pollution control program." National Air Pollution Control Admin., Durham, N.C. 19 pp. (July, 1968)

Advances in technology have made it possible to establish zoning performance standards, which will prevent air-use/land-use conflicts. In the past, such standards were based on source capability and were uniformly inadequate. Now, because of the ability to predict air pollution levels, standards that accomplish both preventive and control aims can be applied. Land area, as used for urban planning purposes, reflects the diffusion capability and greater knowledge concerning the diffusion of pollutants in the air, prediction systems are within practical application range. An example of the output information from such a diffusion model is discussed.
Source: 5

#1820
Williams, R. J. H., M. M. Lloyd , and G. R.Ricks. "Effects of atmospheric pollution on deciduous woodland. I: some effects on leaves of Quercus petraea (Mattuschka) leibl." Environ. Pollut., 2(1):57-68 (July 1971).

The levels of sulfur dioxide and particulate matter in the atmosphere around a smokeless fuel plant in South Wales have been measured in an adjacent area of deciduous woodland by the corrosion rate of zinc battery cases and from analysis of leaves of Quercus petraea. Results show there exists a marked seasonal trend in SO2 levels in the woodland, which was not apparent in an earlier study, although there is a no marked spatial variation. In contrast, the particulate matter is a serious pollutant in the vicinity of the fuel plant and there exists a definite gradient of deposited matter on the oak leaves, decreasing with distance from the source. This surface deposit results in a signficant increase in the number of stomata with particulate matter in their pores and probably affects epidermal permeability. SO2 uptake into these leaves is probably enhanced resulting in higher levels of total sulfur. Increased sulfur presumably accumulates as free sulfate which results in more acidic conditions within the leaf that affect the degradation of chlorophyll, bringing about the early senescence of leaves in the vicinity of the fuel plant.
Source: 1

#1090
Wilson,L. "Application of the wind erosion equation in air pollution surveys." J. of Soil and Water Conserv., 30(5):215 (1975).

To help determine the extent of natural dust in the atmosphere, the author applied the wind erosion equation on a generalized and regional basis in several areas of New Mexico. This application involved the use of wind erodibility ratings for soil associations according to texture class and assumed that range-land vegetation has a protective effect equivalent to standing small grain stubble. Use of roughness and climate variables followed standard U.S. Department of Agriculture procedures, but the author deleted the field length variable. The author considered 0.3 percent of the calculated gross erosion to contribute to the atmospheric dust load measured in urban centers. But even this amount of dust is enough to exceed air pollution standards in some urban areas. Pollution from wind erosion is certainly a legitimate concern of environmental agencies and provides a reason to encourage proper land use management practices. However, it makes little sense to require expensive government actions to reduce such pollution in order to meet existing standards. Instead, enforcement can be directed elsewhere, to areas where pollution is the direct result of human action and, therefore, subject to reduction. Properly used, the wind erosion equation promises to be of considerable value in helping separate naturally dusty areas from those where pollution is of immediate concern. It thus will aid the process of allocating the limited funds and manpower available for pollution control.
Source: 1

#718
Wilton, A.C., J.J. Murray, H.E. Heggestad, and F.V. Juska. "Tolerance and susceptibility of Kentucky bluegrass (Poa pratensis L.) cultivars to air pollution: In the field and in an ozone chamber." J. Environ. Quality, 1(1):112-114 (Jan - March 1972).

During the late summer and autumn of 1970, differential injury, believed to be due to air pollution, was observed on five Kentucky bluegrass (Poa pratensis L.) cultivars: Merion, Kenblue, Windsor, 117-27-6, and Belturf. Belturf was injured most, 117-27-6 least, and the other three cultivars were intermediately damaged. Damage was less severe on parts of plots fertilized with nitrogen at 293 kg/ha than on parts of plots fertilized with 146.5 kg/ha of N. Subsequent tests of three of these cultivars in an ozone chamber (30 pphm for two and four hours) showed cultivar injury ratings corresponding to field injury ratings. Belturf was most severely injured, Windsor next, and 117-27-6 least. Differences among clutivars were highly significant at both levels of ozonation. Injury was significantly greater when ozone was applied at 30 pphm for four hours, than at the same level for two hours. The 117-27-6 was unique in that it tolerated ozone considerably better than did previously investigated Kentucky bluegrass cultivars. The chance selection of this extremely tolerant clutivar was possibly related to its having been selected from M3 progeny of irradiated Merion seed. Bluegrass may build up some tolerance to repeated ozone treatments.
Source: 1

#250
Wislicenus, H. "Resistenz der fichte gagen saure rauchgase bei ruhender und bei thaetiger assimilation." [Resistance of spruce against acid smokes in periods of passive and active assimilation]. Tharandter Forstl. Jahrb., 48:152-172 (1898).

The resistance of spruce to sulfur dioxide emissions during nighttime and winter periods of passive assimilation was investigated in greenhouse experiments over 50 days. Spruces accommodated to nocturnal conditions in an atmosphere containing SO2 showed not even microscopically detectable damages, while actively assimilating trees died in 4 weeks. However, the sulfur trioxide content in the dry matter of needle samples with largely the same with 0.420 and 0.421%, compared with 0.245% in the control group. The SO3 content in needles from spruces exposed to SO2 during the winter period was 0.483% compared with 0.405% in the control group. No damage due to SO2 was observed. Surprisingly great differences in the resistance of the same plant occurred depending on exposure during daytime, nighttime, or winter. The function of the stomata under conditions of chronic exposure was negligible, and SO2 affected primarily the assimilatory function, while its effect on the function of the plasma and on transpiration was of secondary importance.
Source: 1

#251
Wislicenus, H. "Zur Beurtheilung und Abwehr von Rauchschaeden." (The assessment and control of smoke damage). Z. Angew. Chem. (Weinheim), 14(28): 689-716 (1901).

The assessment of smoke damage in a given case involves the gathering of evidence that the damage has indeed been caused by smoke, the rendering of proof of such damage, evaluation of its extent, and the estimation of damage for purposes of indexing. A methodology of smoke damage assessment on crops must include examination of the spot, consideration of other contributory factors (frost, mismanagement), labratory tests, differentiation between acute and chronic damage, determination of the contributory share of several pollution sources, and the calculation of the actual damage accrued. Normal and abnormality high concentrations of pollutants (carbon monoxide, sulfur dioxide and trioxide, hydrogen chloride and fluoride, chlorine, carbon disulfide, cyanide, ether, gasoline vapors, hydrogen sulfide, and ammonia) in emissions from acid manufacturing plants, glass works, lime kilns, fertilizer plants, brick kilns, ceramic works, paper mills, dye works, sugar mills, the manufacture of explosives, and from railroad locomotives are tabulated, and the physiological effects of the various pollutants on plant tissues, on chlorophyll formation, and on assimilation in crops, deciduous trees, and conifers, and sampling and the analytical detection of sulfur and of fluorine in the samples are reviewed. One way of controlling smoke damage is to desulfurize coal by coking and to recover the sulfur by washing coking gas in an alkaline bath. Another way is to achieve a greater dispersion of emissions in the atmosphere by modifications in furnace and smokestack construction.
Source: 1

#142
Witherspoon, J. P., and F. G. Taylor, Jr. "Retention of a fallout simulant contaning ^{134}Cs by pine and oak trees." Health Physics, 17:825-829 (1969).

Small white pine (Pinus strobus) and red oak (Quercus rubra) trees were contaminated in the field with a fallout simulant consisting of 88-175 μ dia. quartz particles containing ^{134}Cs. Whole plants were harvested at intervals up to 33 days after application of the simulant, and the ^{134}Cs retention by each species was determined.

The initial fraction of the stimulant retained by foliage was higher in the oaks (0.35) than in the pines (0.24). However, after 1 hr., the broad leaved oaks had lost 90.5% of the initial ^{134}Cs concentrations while the pines had lost only about 10%. These early retention differences are related to the effects of wind on the two distinct foliage types.

Effective half-lives were calculated for both species at intervals of 0-1 day, 1-7 days and 7-33 days. For pine trees these values were 0.25, 4.53 and 20.66 days, respectively. For oaks they were 0.12, 1.41 and 24.86 days. Loss of particles (^{134}Cs) was due, primarily, to the weathering action of wind and rain during the study. The effects of wind and the first rain following contamination accounted for a large percentage of the total radionuclide loss during the study.
Source: 7

#91
Witherspoon, J. P., and F. G. Taylor, Jr. "Retention of 1-44 μ simulated fallout particles by soybeans and sorghum plants." Health Physics, 21: 673-677 (1971).

Six-week-old soybean and sorghum plants were contaminated in the field with a siliceous fallout simulant containing ^{134}Cs. Initial fallout interception and retention of particles by whole plants and plant parts were determined for a 5 week period. Initial interception of particles was similar with values of 39.5 and 38.2% of the deposition quantity retained by soybeans and sorghum, respectively. Sites of initial interception, however, differed greatly between species. Weathering half-lives for particles were determined for different plant parts and for two time components (0-7 and 7-34 days following deposition). Half-life values were similar for the 0-7 day component, but differences between species and plant parts were found for the 7-34 day component.
Source: 7

#1819

Wolfe, R.R., D.P. Anderson, F.L. Cherms, Jr., and W.E. Roper. "Effect of dust and ammonia air contamination of turkey response." Trans. ASAE (Am. Soc. Agr. Engrs.), 11(4):515-518, 522 (1968). Presented at the American Society of Agricultural Engineers, Annual Meeting, Saskatoon, Sask., Canada. Paper 67-424 (June 1967).

The effect of dust and ammonia air contamination on turkey response was investigated in three 12 wk trials. The incidence of airsacculitis at slaughter was significantly affected by the dust air pollution. Increasing the dust contamination from 0.1-0.4 mg/cu ft to 0.6-1.0 mg/cu ft caused more than double the rate of airsaculities. No effect of ammonia concentrations of 0-8 ppm to 20-30 ppm on airsacculitis was detected. Interaction between dust and NH_3 was not significant. Mortality rates and feed conversion of the turkeys were not affected by the dust and ammonia treatments. Birds exposed to the high dust and ammonia concentrations showed considerable loss of cilia from the epithelium lining the trachea and an increase in mucus secreting goblet cells. The high dust area caused areas of consolidation to appear in the lungs which would adversely affect their functional capability for oxygen/carbon dioxide exchange.
Source: 1

#1818

Wolff, G. "Die Interpretation falschfarbiger Luftbilder im Dienste der Rauschschadendiagnose." (The interpretation of miscolored aerial photographs in the service of pollution damage assessment). Polska Adademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, p.285-295 (Sept 9-14, 1968).

A film with a superimposed panchromatic and infared sensitive emulsion exposed simultaneously will, when developed, yield composite color effects based on the photochemical function of miscolorations, permitting the differentiation of healthy from pollution-damaged conifer crowns. The more severe the damage to pine needles and the older they are, the smaller their emission in the infared spectrum. The explanation probably lies in anatomical structural changes or in an accumulation of necrotic substances or tissues. Another factor may be that damaged trees have fewer needles and thus expose more the the bark surface. From such spectrozonal aerial photographs on a scale of 1:5000, the condition of individual pine and spruce tree crowns can be evaluated with considerable accuracy (healthy, slightly damaged, severly damaged, dead), while on a scale of 1:10,000 such evaluation is no longer possible. A comparison of aerial and terrestrial evaluation methods yielded a 60 to 90% accuracy for the aerial photographic evaluation method. The method, when correlated with a terrestrially determined damage scale, can be used for rapid evaluation of pollution damage to large wooded areas.
Source: 1

#252
Wolozin H., and E. Landau. "Crop damage from sulfur dioxide." (Presented at the Joint Meeting of the American Farm Economic Association and Econometric Society, New York City, Dec. 29, 1965.) J. Farm Economics, 48(2):394-405 (May 1966).

Air pollution is not a new problem in agriculture, nor is it one which has been adequately assessed. Many industries located near agricultural areas are emitting clouds of toxicants, causing extensive damage to nearby crops. The best estimates available indicate that direct damage inflicted by air pollution on farm crops and livestock are running at approximately 1/2 billion dollars a year at prices paid the farmer, with possibly one-third attributable to sulfur dioxide. This may not appear to be one of our graver problems in view of the fact that pests, primarily insects, cost the agricultural economy in excess of 13 billions each year. However, agricultural injury by air pollution in contrast to that by pests is not evenly distributed over the United States but is localized and may been severe in urban localities, particularly if the crops, forests, or livestock are located in the vicinity of large power or phosphate plants or are close to automotive traffic and congestion. An examination of the available data on damage to crops due to the toxicant, sulfur dioxide, whose effects account for 1/3 of the total, would seem to indicate that estimates based on the presently existing means of measuring such costs seriously understate the damage.
Source: 1

#1817
Woltz, S.S. "Fluoride toxicity in gladiolus and methods of amelioration." Proc. Florida State Hort. Soc., 75:469-471 (1962).

The protection of gladioli from fluoride by spraying is described. Fluorine leaf scorch symptoms were identified using specimens fumigated with 0, 0.48, 0.95, 1.9, 3.8, and 7.6 mg hydrofluoric acid. The leaf-tips and margins turned grayish-green the second day following exposure; by the third day the leaves turned grayish white or tan; by the end of a week the damaged area had a burned appearance with tan to dark brown color. In a field experiment, plants were exposed to fluoride sprays as pesticides under controlled conditions. Calcium, manganese, and magnesium had protective effects through the inhibition of metal-requiring enzymes. The field experiment showed leaf scorch systems were produced on gladioli by sodium fluroide and hydrofluoric spray treatment. The effects of HF were almost as great, even though after drying any unreacted HF was lost to the atmosphere. No reduction in foliar toxicity resulted from soil applications of calcium sulfate, apparently due to a greater native calcium supply. Both sodium fluoride and HF were effective in foliar sprays used to stimulate fluoride leaf scorch.
Source: 1

#253
Woltz, S. S. "Distinctive effects of root versus leaf acquired fluorides." (Meeting was held in Miami, Fla., Nov. 3-6, 1964.) Proc. Florida State Hort. Soc., 77:516-517 (1964).

In connection with studies of the effects of fluoride air pollution on plant growth, the question arises as to whether soil borne fluorides may contribute significantly to the fluoride content of plants and thus add to the toxicity of airborne fluorides. After extensive research, MacIntire and others concluded that with normal agricultural soils of low acidity, fluoride uptake by the roots does not occur to any significant degree. The experiments to be reported were carried out to determine the applicability of these conclusions to Florida conditions and to determine whether the effects of soil fluorides could be distinguished from those of atmospheric flouride.
Source: 1

#719
Woltz, S.S., W.E. Waters, and D.C. Leonard. "Effects of fluorides on metabolism and visible injury in cut-flower crops and citrus." Fluoride, 4(1):30-36 (Jan. 1971).

Experiments were conducted to determine the susceptibility of horticultural crops grown in Florida to damage from fluorides. Atmospheric fluorides were considered, as well as fluorides derived from soil and water. Fluoride taken up by gladiolus roots caused foliar damage only when soil pH was low and F(-) containing superphosphate was applied in relatively excessive amounts. The damage to leaves occurred more to leaf interiors than to margins and tips as in F(-) fumigation. Fluoride in leaves moved passively with the transpiration stream of water and accumulated at the terminus of translocation. Rose and gladiolus cut flowers were damaged by low F(-) concentrations in vase water, while chrysanthemums were less affected by novo chlorophyll synthesis in Vigna sinensis seedling leaves was inhibited by F(-) absorbed by detached seedling tops. The yield of Valencia orange fruit was depressed by airborne F(-). Valencia leaves were reduced in size, had decreased photosynthetic rates, and had decreased chlorophyll content in response to increasing levels of airborne F(-).
Source: 1

#1078
Wood, F. A. "Air pollution and shade trees." Proc. 43rd Int. Shade Tree Conf. (August-September 1967) p. 66-83.

Types of tree-damaging compounds, and their source is discussed, with some discussion on the photochemical reaction. Effects on plants (necrosis, chlorosis, or atrophy) is reviewed. Effects are classified as either acute, or chronic. Environmental factors condition or change the response of a plant to a specific pollutant. Effects of plants to various pollutants are given. Future trends are discussed, with a variety of graphs and maps to demonstrate.
Source: 8

#1137
Wood, F. A. "Air pollution and the roadside." Horticulture, 46(2):36-37, 45 (1968).

Hydrocarbons and oxides of nitrogen pose a big threat, because they are precursors of more toxic photochemical pollutants. Autos are the most important single source of these pollutants, so the problem along roads is due mostly to photochemical substances. Peroxyacetal nitrate (PAN) is a difficult compound to work with, so most of the information obtained concerning it is a result of studies on vegetable and citrus crops in southern California. Long term, low, exposures of various air pollutants may result in gradual weakening of the tree and leave it open to attack by relatively harmless pathogens. It is reasonable to assume that O_3, PAN and similar compound represent the most important specific pollutants in the roadside environment.
Source: 8

#1816
Wood, Francis A. and John B. Coppolino. "The influence of ozone on decidous forest tree species." Mitt. Forst. Bundesvers., 97:233-253 (1972).

Seedlings of 21 species of deciduous trees commonly found in the northeastern United States were exposed to ozone in dosages of 25 pphm for 4 to 8 hours and to 10 pphm for 2, 4, 6, or 8 hours at 21 C, a relative humidity of 75%, and 1400 ft-c of light. All plants were exposed to 1 hour of darkness prior to fumigation. Symptoms of damage developed on green ash, white ash, sweet gum, pin oak, scarlet oak, white oak, hybrid poplar, mountain ash, sycamore, redbud, honeylocust, and tulip poplar following exposure to 25 pphm ozone for 8 hours. The most common symptoms were stipples of the upper leaf surface, necrotic flecks, overall leaf chlorosis, marginal leaf necrosis, overall leaf necrosis, and tissue collapse. Exposure of these species to 25 pphm ozone for 4 hours injured green ash, white ash, mountain ash, honeylocust, white oak, hybrid poplar, and tulip poplar. Exposures at 10 pphm for 8 hours injured white ash, honeylocust, hybrid poplar, tulip poplar, and sycamore. Symptoms failed to develop on European white birch, gray dogwood, flowering dogwood, little-leaf linden, Norway maple, sugar maple, English oak, red oak, and shingle oak exposed to 25 pphm for 8 hours. The incidence of sensitive plants within the seedling population of each species ranged from 19 to 100% with the exception of white ash, all species were resistant during the first 2 weeks of growth following bud break in the spring.
Source: 1

#1120
Woodruff, N.P. and A.Q. Zingg. "Wind tunnel studies of shelterbelt models." Journ. of Forestry, 51(3): (1953).

Wind tunnel studies were conducted to obtain information on the following two phases of the shelterbelt problem: (1) the effect of the number of rows within a shelterbelt, and (2) the general design and orientation of shelterbelts with respect to the direction of the prevailing winds. Models of a 5-row, 7-row and two different designs and two orientations of a 10-row shelterbelt were used in a wind tunnel to obtain this information. The influence of the shelterbelt both at the ground surface and at elevations extending to three times the height of the tallest trees is given. Pitot tube measurements of horizontal velocity, velocity profile maps and shear or erosion patterns in sand are employed to describe the flow about the shelterbelts. The different shelterbelts are ranked according to their effectiveness in reducing the velocity at the ground surface and at elevations above the surface. A 10-row shelterbelt of conventional design was found to be the most effective at both levels. The alternate designs of 10-row belts were less effective or were variable in their effectiveness, with some designs showing relatively more effectiveness at higher elevations than at the surface. The 5- and 7-row shelterbelts were found to offer nearly as much protection as the 10-row designs.
Source: 8

#1599
Woodwell, G.M. and W.R. Dykeman. "Respiration of a forest measured by carbon dioxide accumulation during temperature inversions." Science, 154(3752): 1031-4 (Nov. 25, 1966).

Nocturnal accumulations of carbon dioxide during 40 temperature inversions in one year were used as an index of the metabolic activity of a forest. Rates of CO_2 production varied with temperature and with season. Spring and summer rates were 2 to 3 times higher than winter rates at the same temperature. Mean monthly temperatures, averaged over 15 years, were used with the curves of respiration on temperature to compute annual gross respiration of the Brookhaven oak-pine forest. The forest was estimated to have a yearly release of approximately 3400 grams of CO_2 per square meter; theoretically equivalent to 2104 grams of dry matter (carbohydrate).
Source: 1

#1146
World Meteorological Organization. Windbreaks and Shelterbelts, Tech. Note No. 59, Geneva, Switzerland, 188 p. (1964).

This report deals with the effects of shelterbelts and windbreaks on microclimate, soil climate, soil erosion and on plants and animals.

The main effect of shelterbelts and windbreaks is to reduce surface wind speed. The change in microclimate and soil-climate, in plant growth and in animal life is mostly a consequence of the reduced wind speed. The horizontal range of wind reduction by a belt is proportional to the height (H) of the belt. The percentage wind reduction is independent of wind speed with small exceptions. The permeability of shelterbelts to air flow is the main factor affecting the distribution of wind speed on the leeward of the shelter.

Very dense shelterbelts cause a strong reduction immediately behind the belts, connected with eddies and strong turbulence. The distance from the belt at which the free open wind speed is reestablished is relatively small. Behind shelterbelts with a permeability of 40 to 50 per cent the zone of wind reduction is the most extensive. The minimum of wind speed is at a distance of four to six times the height of the belt. The degree of wind reduction by shelterbelts of different widths depends chiefly on their permeability. Other factors influencing the wind reduction by shelterbelts are the roughness of soil surface and the stability of the air. The range of wind reduction increases with decreasing surface roughness and with increasing air stability.

The layout of shelterbelts depends on their purpose. Furthermore, consideration must be given to the proximity of adjacent belts as several parallel belts produce an effect different from that of a single isolated belt. The question of optimal spacing cannot be easily answered, since it depends on many factors. Very frequently a rectangular network of shelterbelts gives the best wind reduction because of the variation in wind direction.

Radiation is reduced by shelterbelts only in the immediate vicinity. Generally a small increase in the daytime soil and air temperature behind shelterbelts can be found. Shelterbelts can increase the risk of late spring frosts on slopes where air drainage is impeded but have little effect on risk of radiation frosts in flat fields during calm nights. The influence of shelterbelts on air humidity is likewise not uniform. Generally an increase in relative humidity and in the amount of dew fall can be observed at night. Shelterbelts have a large influence on the distribution of precipitation in their immediate vicinity but produce no significant increase in the amount of general precipitation in the sheltered area. In climates with severe winters and dry summers the main purpose for planting shelterbelts is often for the accumulation of snow behind them. The formation of snow-drifts depends largely on the density of the shelterbelts.

The reduction of potential and actual evapotranspiration and of the loss of soil moisture by reducing the wind speed is frequently the main purpose of shelterbelts. But the amount of reduction of evaporation is smaller than the reduction of wind speed because the evaporation depends on the square root of wind speed and also largely on the amount of radiation, which is not influenced by shelterbelts. Behind very dense belts the evaporation can increase in spite of wind reduction due to higher turbulence.

An increase in the CO_2 content of the air near the soil surface by shelterbelts could not be found. The effect of belts on growth, yield and quality of crops and fruits varies with climate, soil and the type of plant itself. The main effect on yield is mostly due to the better water supply and frequently due to higher temperature. Fruits and vegetables and other special crops normally react better to wind reduction than cereals, forage plants and other agricultural crops. The financial return of crops planted in a wind-sheltered area can also be increased by a better quality and earlier ripening.

A number of other topics are discussed in the text, namely, shelterbelt design ; wind flow through gaps and at ends; problems in hilly areas; the influence of forests on wind; the complex problem of soil erosion control; and protection for farm animals, farm buildings and pastures; and the planting, care and maintenance of shelterbelts.
Source: 5

#720
Wullstein, L.H. and Kristen Snyder. "Arsenic in the ecosystem." Presented at the International Air Pollution Conference, 4 p. (1970).

The effects of arsenic on rates of mineralization in soil were investigated using samples subjected to pollution from a copper smelter. The samples contained up to 245 ppm arsenic compared with control samples containing 10 ppm arsenic. Mineralization was studied by adding a constant amount of peptone to the samples and comparing the rates of ammonification, nitrosofication, and nitrification. Then concentration of 50, 150, and 250 ppm arsenic were added to the control samples and similar mineralization rates were determined. Ammonification rates of the polluted and control samples amended with both peptone and arsenic were similar; however, rates at which ammonium was oxidized differed. Nitrosofication and nitrification rates of the polluted samples were reduced compared to those of the control samples. Field methods of soil sampling, laboratory procedures, including determination of moisture, pH, total and gaseous arsenic, total N and soil Rg and complete test results are discussed.
Source: 1

#1815
Wylie, P.B., and L.C. Bell. "The effect of automobile emissions on the lead content of soils and plants in the Brisbane area." Search, 4(5):161-162 (May 1973).

Considerable accumulations of lead were found in soils and plants adjacent to highways of moderate traffic density (3700-16,000 vehicles/day) leading from Brisbane. At 2 m, soil lead contents of 10-120 micrograms/g above background levels (18-24 micrcgrams/g were measured by atomic absorption spectrophotometry. Plants (Rhodes grass) contained up to 64 micrograms/g lead. While these leads do not pose an impmediate threat to plants, animals, or human health, the continuing buildup of lead in the environment cannot be ignored. As traffic densities on many roads in Brisbane approach 50,000 vehicles/day, a more detailed survey of lead accumulation in the city is being undertaken.
Source: 1

#1596
Yabuki, Kazutoshi and Masatoshi Aoki. "Sekigai kara koku shashin ni yoru shokubutsu kassei no seitai chosa." (On the ecological survey of plant activity by infra-red color aerial photography). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):596 (Oct. 1973).

Infared color aerial photography was used to investigate the conditions of vegetation in Osaka prefecture. The areas surveyed were Sakai and Tanagawa and the trees surveyed were black pine and oak. A photo-pattern analyzer was used and the conditions of trees were expressed by the ratio of red and blue photo permeation volumes. In the Tangawa area, there was a clear difference in the condition of black pines in polluted and non-polluted areas. The photosynthetic capability distribution of coral trees in Sakai, and the activity distribution of black pines in the Tangawa area, and the activity distribution of oak in the Sakai area are presented by maps.
Source: 1

#1952

Yagovoi. P.N., V.I. Shendevitskii, and N.N. Ivchik. "K voprosu o zaderzhke radioaktivnoi pyli zelenymi nasazhdeniyami." (Trapping of radioactive dust by green plantations). Hyg. Sanit. 31(7):106-10 (July, 1966).

It has been established that smoke dust adsorbs radioactive substances from the air. An experiment was performed to test the hypothesis that the radioactivity of plants should be higher in areas polluted with smoke discharges due to the capacity of the foliage to trap dust. The leaves of certain tree and scrub species were sampled in Leningrad and in a park in Pavlovsk. In Leningrad, the samples were taken at varying distances from a coal burning power plant. It was found that the park leaves contained less radioactivity than the Leningrad leaves. However, it was also demonstrated that the leaves of some species had an increasing amount of radioactivity as distance from the power plant increased, while in other species the reverse occurred. Results indicated that this was due to the variation in the size of the dust particles which the different species were capable of trapping.
Source: 1

#1814

Yamaga, Mineo, Kaoru Omori, Kazunori Abe, and Takashi Tozawa. "Taiki osen no shokubutsu ni oyobosu eikyo - tosuikai koso e no ozon no eikyo." (The effects of air pollutants on vegetation - The effects of ozone on carbohydrase). Proc. Symp. Japan Soc. Air Pollut., 13th, Paper 184, p. 230 (Nov 7-9, 1972).

The effects of ozone on the carbohydrate of plants were examined by both in vivo and in vitro experiments using young shoots of cucumber and kidney beans. Oxone was led into an exposure chamber which was kept at 20 C, humidity 50% and 1000 lux. The concentration of ozone was maintained at 0.5 ppm, checked by the neutral potassium iodide continuous automatic meter. The shoots were exposed for 2 hr; immediately after that 1.0 g of leaves was measured and homogenized with distillate water. Ammonium sulfide was added and the precipitation was analyzed. The pH of sucrase of the cucumber was approximately 4.5, that of beans was about 5.0, and the beta-amirase of the beans was 5.5. Acetic acid buffer liquid containing 2% sugar was added and reacted at 30 C and the carbohydrase activities were measured. The vitro experiments showed a clear effect of ozone, lowering activities of all the enzymes. The deterioration rate of cucumber sucrase was 25% in 5 min, whereas the control group deteriorated only 5%. In 10 min the control group activity lowered 10%, and the exposure group lowered 40%. The activities of sucrase and betaamirase of kidney beans also lowered 20% in 5 min and 40% when the control group lowered 12%.
Source: 1

#254
Yamaga, S., K. Ohmori, H. Saito, and A. Tanizaki. "Jidosha haiki gasuchu namari no kakusan ni tsuite." (The diffusion of lead in automobile exhaust gas). Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):256 (1970).

The pattern of diffusion of lead from automobile exhaust gas was investigated by studying the amount of lead adhering to or contained in leaves of ginkgo trees growing along less-travelled roads that cross a busy highway. Samples were dried at 100 C, then pulverized, and a definite portion wet-digested. After extraction by dithizone, lead was determined by atomic absorption spectrophotometry. The same routine was followed for surface soil at the root of the trees. Leaves at heights of 3 and 6 m were examined. At one of the two sampling sites, the lead content in surface soil tended to decrease with distance from the truck highway. At both sites, the amount of lead in leaves tended to decrease with distance from the main highway. Lead was found in larger amounts in the leaves at the lower level. Also, those leaves collected in October contained more lead than those assembled earlier in the year.
Source: 1

#1813
Yamagata, Noboru. "Environmental sampling and measurement methods." Japan Public Health Assoc., Proc. Sci. Res. Meet. Itai-Itai Dis. Cadmium Poisoning, Tokyo, Japan, (Aug 28-29, 1971).

Methods for the sampling and analysis of environmental cadmium are discussed. The procedure used in measuring the Cd content of soil or harvested rice is used as an example. The processes involved include object (e.g.,rice paddy) selection, on site, sampling, laboratory sampling, chemical pre-processing, and equipment analysis. For a paddy covering about 10 acres,it is sufficient to sample the surface soil at about 10 points, and to analyze a well-mixed sample; it is advisable to sample sections below 70 micron in the analysis of bottom material. If the goal is to estimate the degree of rice pollution from the results of soil analysis, the extraction of soil water and extraction with pH 7 ammonium acetate are recommended. Sixty kilogram samples of unhulled rice from both Yamagata and Toyama Prefectures were prepared as standard samples, since both samples naturally contain Cd. To determine the reliability of the atomic absorption photometer in the analysis, nine different kinds of photometers made by five different companies were used to measure the sample solution. One of the standard rice samples was analyzed by the APDC chloroform method and the low-temperature ashing-acid extraction method. The fluctuation rate of analytical values with the wet ash-solvent extraction method is about 10%. The reliability of measurement using the atomic absorption method increases if measurements at the low concentration region near the base point are avoided. It also increases if the chemical preprocessing is simplified and the low-temperature ashing-acid extraction method is adopted. It is more effective to simplify the preprocessing considering production and distribution of standard samples than to standardize the analytical methods by specifying the choice among solvent extraction methods.
Source: 1

#1126

Yamate, G. "Development of emission factors for estimating atmospheric emissions from forest fires." U. S. Environmental Protection Agency, Office of Air and Water Programs, Office of Air Quality and Standards, Research Triangle Park, N. C.,27711, October 1973. EPA-450/3-73-009.

The objective of this project was to develop emission factors (weight of pollutant per acre burned) for estimating emissions from forest fires, especially wildfires. The pollutants of interest were particulates (filterable and total), hydrocarbons (reactive or unreactive), carbon monoxide, nitrogen oxides, and sulfur oxides. The effects of terrain, density of vegetation coverage, type of vegetation, wind speed, and humidity were to be expressed as adjustment factors to the average emission factors. Also, emission factors were to be developed for the five geographical forest areas of the country. Information from the literature and unpublished test work were to be used to develop the emission factors.

The information sought for each forest area were:

1. The number of acres burned by wildfires.

2. The quantity of fuel available, or preferably, the fuel consumed by the average wildfire.

3. Measurements of emissions from burning forest fuels.

4. The effects of fire behavior variables on emissions.

Acres consumed by wildfires for each geographical forest area were obtained from a compilation of wildfire statistics prepared by the Division of Cooperative Forest Fire Control of the USDA Forest Service. No comparable set of statistics was available for acreage burned by "managed" fires.

Fuel data were also obtained from Forest Service reports and contacts with regional Forest Service laboratories and personnel. The Forest Service periodically undertakes a forest survey of commerical timber and studies forest fuels for fire prediction, prevention, and control. They now consider fuel assessment to be of major importance. Past and present fire reports describe fuels by forest tree type. However, the National Fire Danger Rating System (NFDR) is now operational and each region measures standing timber and fuels for use in fire models. These models recognize the importance of the size of forest fuels rather than type. They emphasize the fine forest fuels with a tendency to burn, rather than the amount potentially able to burn.

The emissions produced by the burning of forest fuels were obtained through an intensive information search and site visits to several fire laboratories. No emission data were available from wildfires. Experimental measurements of the emissions were tabulated for comparison and found to be consistent, with the exception of the values for carbon monoxide. Carbon monoxide is an anomaly, since burning behavior (temperature, duration, and oxygen supply) and the point of sampling radically alter the results. During informal discussions

#1126 (cont.)
at the 13th Tall Timbers Fire Ecology Conference, references were made to the close agreement among emission measurements made at the Southern Forest Fire Laboratory, the bushfire smoke studies by an Australian study team, and the results reported by Dr. E. F. Darley at the University of California, Riverside. Emissions per ton of forest fuel appear to be independent of tree type and other variables, from a practical viewpoint. Using our best engineering judgment, the following emission values or pollutant yields were selected as representative of average forest fuels:

Pollutant	Pollutant Yield, lbs/ton of fuel
Total Particulate	17
Carbon Monoxide	140
Total Hydrocarbon (As CH_4)	24
Nitrogen Oxides (As NO_x)	4
Sulfur Oxides (As SO_2)	Neg.

Source: 8

#1812
Yamamoto, Y. "Present status of cadmium environmental pollution." (Japan). Proc. Sci. Res. Meet. Itai-Itai Dis. Cadmium Poisoning, Tokyo, Japan (Aug. 28-29 1971).

A survey of 50 regions in the vicinity of zinc mines or refineries was undertaken to provide information on the nature of cadmium pollution in regions other than those in which itai-itai disease had been observed. The maximum Cd concentration, maximum average regional Cd concentration, and general average Cd concentration are given for the unhulled rice, paddy field soil, drinking water, river and sea water, drainage water, river bottom soil, agricultural products other than rice, fish, shellfish, and seaweed in the regions surveyed. The maximum Cd concentration in the ambient air was 2.59 micrograms/cu m; the maximum average regional concentration was 0.04 micrograms/cu m; and the general average value was 0.04 micrograms/cu m. The number of samples exceeding 0.88 micrograms/cu m was three; they were in the Hikoshima and Omuta regions. The relationship between the cadmium concentration in unhulled rice and that in the paddy soil is shown by the equation y equals 0.031x + 0.125, where x is the Cd concentration in the soil and y is that in the rice (in ppm). Survey results are also given of 1146 rice samples grown in seven regions requiring environmental observation because of known Cd pollution.
Source: 1

#1918
Yamasaki, Morimasa and Kiichi Nishiyama. "Jumokurui no aryusan gasu teikosei to ensosan kari teikosei tono kankei ni tsuite." (On the relationship between the tolerance to SO2 gas and toxicity to KC103 of many kinds of trees). Tokyo Nogyo Daigaku Nogaku Shuho (J. Agric. Sci., Tokyo Univ. Agric.), 18(2):117-122 (1973).

Branches from broad-leaved, evergreen broad-leaved, and coniferous trees were put in pots filled with 0.05% solution of potassium chlorate and judged for injurious symptoms as revealed by leaf lesion and coloring in a study of KC103 resistance as compared to sulfur dioxide resistance. The results indicated a close positive correlation between KC103 and SO2 resistance, and it is therefore convenient to use KC103 as a substitute for the SO2 gas method in SO2 resistance studies. Other experiments involving trees transported from various regions of varying temperature were used to show that trees from warmer regions are generally more resistant to KC103 than those from cooler localities. Trees transported from warmer regions may be assumed to be generally more resistant to SO2 gas than those from cooler areas.
Source: 1

Yamate, G. "Emissions inventory from forest wildfires, forest managed burns, and agricultural burns." U. S. Environmental Protection Agency, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, N. C. 27711, EPA-450/3-7-062 (November 1974).

This project was conducted to complete the National Emissions Data System (NEDS) area source inventories on emissions from forest wildfires, forest managed burns, and agricultural burns for each of the 55 states and territories. The objective was to obtain and provide reliable data and information on acreages burned and tons of fuel burned per acre for each of the categories in the approximately 3,100 counties and other jurisdictional entities in the country,

The data and information was obtained from the U.S. Forest Service; Bureau of Land Management; Bureau of Indian Affairs; and the various state forestry, agricultural, and environmental agencies. A limited number of industry (trade associations), academic, and independent personnel were contacted for specific information.

The information retrieved were evaluated and the most reliable selected for use. Where source data values conflicted, adjustments were made. Estimates were derived for states on the basis of land area, forest area, farm and crop area, and verbal descriptions of the fire activity. No estimates were made where no data whatsoever was available.

The pertinent data were entered on area source coding forms provided by the Project Officer and using his data entry guidelines. These completed source coding forms were then forwarded to the Project Officer for examination, comments corrections, and final use.

This report summarizes the information on the area source coding forms for 55 states and territories, the information source or sources, and if an estimating and/or proportioning method were utilized. The state forest wildfire information was adjusted to an average 10-year value as calculated from the Federal "Wildfire Statistics" which is published annually by the U.S. Forest Service, Division of Cooperative Forest Fire Control. County breakdowns for the states were either supplied by state personnel or estimated on the basis of verbal or published references to the specific burning practice in that state.
Source: 8

#377
Yamazoe, Fumio. "Fukkabutsu ni yoru shokubutsu higai to sono jittai." (Injury to plants exposed to fluorides). Kogai to Taisaku (J. Pollution Control), 9(4):331-338 (April 1973).

Fluoride emission sources, emission standards, plant damage, plant resistance, damage factors, damage characteristics and mechanisms, the evaluation method for F damage, and the control or attenuation method for F damage are discussed. Plant leaves which absorbed fluoride generally turn yellow on the tips and around the edges; when the roots absorb F, a slighter degree of discoloration and withering occur. Silicicolous plants such as rice and wheat form a compound of silicon and F which is relatively insoluble, and calcicolus plants such as soybeans and colza seed form a compound of calcium and F which is also insoluble. These compounds stay in fixed locations. Toxic hydrogen fluoride solutions destroy the cell system and do not transfer to other locations. They usually damage the metabolism; evaporation of water increases temporarily and then decreases; chlorosis occurs and further develops into necorsis; the respiration increases temporarily but gradually decreases; the assimilation of carbon and nitrogen decreases; and the balances of various elements are completely destroyed. The control or attenuation methods for F damages are: the use of an evaporation control agent such as water, lime emulsion, or OED; cultivation of other species with a greater resistance against F damages; improvements of fertilizer and care, avoiding nitrogen fertilizers and replacing them with potassium fertilizers; and planting a buffer area with smoke-resistant trees such as camillia, acacia, or phoenix trees.
Source: 1

#1810
Yamatomo, Takeo. "Kogai to sono shugen 4, Seibutsu riyo to kankyo chosa." (Pollution and its circumference (IV): Biological use and environmental investigation). Kagaku to Yakugaku no Kyoshitsu (Chem. Pharm., Quart. J.), 40:6-11 (1973).

For measurement of traceable sulfur oxide, the use of microbiological quantitation of sulfate ions is reliable and convenient for treating a large amount of test material simultaneously. This method is also useful for examing bacterial proliferation inhibitors or inhibiting factors. Quantitation of sulfates in rain water by the colitis bacteria (Escherichia coli), and the relationship between inhibitors and toxic metals are discussed. The pattern of hydrogen fluoride damages was examined by gladioli and orange leaf experiments. The SOx first damages the plant s spongy parenchyma and then the total system. The damages appear first in spots, and then turn into gray, white or yellow as the symptom advances. The HF can be absorbed in gas form through the stomata of the epidermis and damage spongy parenchyma and palisade, or water soluble compounds in HF can be absorbed into plant. Once absorbed, HF moves to the tips or edges

of the leaves, and the accumulation causes graying or browning of the leaves. Traceable amounts of HF can damage agricultural produce visibly. In the area 1-2 km from the emission source, plants can have approximately 150 ppm, or five times the HF accumulation in a control area. Rats were raised at a street intersection to see the effects of automotive exhaust gas. An interesting and significant inhibition of weight increase was noted among one group of rate. The lead content in the atmosphere or the dust count did not show a significant difference from other exposure areas. In addition to exhaust gases, noise, light and other conditions such as ventilation, temperature, and vibration seemed to have inhibited the growth of rats.
Source: 1

#1809
Yamazoe, Fumio. "Shokubutsu higai no genin to naru taiki osen busshitsu." (The air pollutants which cause plant damage). Shokubutsu Boeki (Plant Prot.), 27(6):220-223 (June 1973).

Ozone and peroxyacetyl nitrate and its homologues cause oxidative damage to plants. Sulfur dioxide, formaldehyde, hydrogen sulfide, and carbon monoxide cause reductive damage. Hydrogen fluoride, silicon tetrafluoride, hydrogen thloride, sulfuric acid mist, and hydrocyanic acid cause acidic attacks. Ammonia causes alkaline attacks. Ethylene, proplene, soots, smokes, dusts, metal, metals oxides, and other particulates also cause plant damage. Pollutants are classified according to order of toxicity as follows: strongly toxic substances causing symptoms as the ppb level such as fluorine, chlorine, and PAN; moderately toxic substances causing symptoms at ppm levels such as sulfur oxides and nitrogen oxides; and fairly toxic substances which cause symptoms at levels between tens and thousands of ppm such as aldehydes, HCl, NH3, HCN, H2S, and CO. Recently, damage due to the synergistic action of two pollutants has been increasing (such as SO2-HF, SO2-PAN, and SO2-03). Origin toxicity, and damage mechanism of major pollutants are discussed.
Source: 1

#1808
Yamazoe, Fumio. "Taiki osen ni yoru norin kogai." (The effect of air pollution on agriculture and forestry). Nogyo Oyobi Engei (Agr. Hort.), 48(1): 133-138 (1973).

The effect of hydrogen fluoride on plants is stronger than on animals. The threshold value of indicator plants (gladioli) is 5-10 ppb/day. The HF can cause etiolation at the tip or fringe of leaves. Silkworms fed leaves polluted by over 30 ppm of HF became ill. Cows exhibit fluorosis effects in teeth and bones after HF exposure. Chlorine turns leaves yellow by causing decomposition of chlorophyll. Plant damage occurs after 2-4 hr of exposure to 0.05-0.07 ppm of ozone or after 8 hr of exposure to 0.05 ppm of peroxyacetyl nitrate. Ozone causes white or brown spots on the surface of leaves; peroxyacetyl nitrate causes silver or bronze spots.
Source: 1

#255
Yamazoe, Fumio and Teruo Nakamura. "On nutritive changes of water field rice plant causes by hydrogen fluoride. Fundamental research concerning smoke pollution on plants." Report 3. Nippon Dojo-Hiryogaku Zasshi (J. Sci. Soil Manure Japan), 31:29-32 (1960).

In order to investigate nutritive effects of smoke pollution caused by hydrogen fluoride gas on plants, hydroponic cultures of water field rice plants were made and contacted with hydrogen fluoride at 500 ppm concentration for 1 hour. The samples were then picked out at the times of minimum and maximum assimilation of carbon after two days, and the yields of every section of the plant as well as various components were measured. Their changes were checked by comparison with those in the control lots. Chlorophyll contents in the rice plants above the ground in the contact lots decreased immensely, accompanied with a decline of increase of carbohydrate at the time when the afternoon assimilation function reaches its highest. This shows clearly that the carbon assimilation deteriorates. Among carbohydrates, the decrease of production of non-reducing sugar was especially noteworthy. Nitrogen in the contact lots, as compared with that in the control lots, showed a decline in pure protein ratio, and demonstrated a tendency toward a large ratio of amide-ammonia nitrogen which was not completely assimilated to the plants. Among inorganic components, the absorption of Potash declined considerably after gas contact, and magnesia tended to stay in the roots. Lime, however, showed scarcely any damage. Silicic acid tended to show an increasing absorption. The sections in the plants where fluorine is contained are the leaf blade, sheath, and root, in that order. Most fluorine exists in the leaf blades. The fluorine doesn't seem to move around in the system after the gas absorption: neither does it purge from the roots. For the prevention of such injurious components and to promote recovery from abnormal metabolism, lime, magnesia, silicic acid, and so forth, should be valuable.
Source: 1

#1807
Yang, Shang Fa and Mahmoud A. Saleh. "Destruction of indole-3-acetic acid during the aerobic oxidation of sulfite." Phytochemistry, 12:1463-1466 (1973).

Indole-3-acetic acid (IAA) was rapidly destroyed in the presence of manganese ions (++), oxygen, and sulfite ion. The optimal pH for the reaction was between 5 and 6. The destruction was dependent on the aerobic oxidation of sulfite, but was not inhibited by superoxide dismutase. Tracer studies indicated that IAA was converted into at least three compounds. Decarboxylation of IAA was not involved in the destruction. This reaction is important in studying the effect of sulfur dioxide in IAA, a natural hormone, in vegetation.
Source: 1

#1806
Yatazawa, M., K. Furuhashi, and S. Tanaka. "Aryusan gasu ni yoru shokubutsu higai no jikkenteki kenkyu (dairoppo), Tansan kotei koso no aryusan ni yoru sogai yoshiki ni tsuite." (Experimental suudies on the plant damage by sulfur dioxide (Report No. 6), the reduction mechanism of photosynthetic activities in plants exposed to sulfur dioxide). Text in Japanese. Japan Society of Air Pollution, Proc. Symp., Japan Soc. Air, 13th, Paper 183, (Nov. 7-9, 1972).

The blocking of the activity of ribulose carboxylase in plants by sulfur dioxide was reported previously. Further studies were made on the recovery damages. Ribulose-1, 5-diphosphate carboxylase was prepared from spinach. The lowering of activity occurred when sulfur trioxide blocks the SH radical of the enzyme protein. The results were compared by adding sodium sulfite to the liquid at the time of reaction, and by pretreating the enzyme liquid with the same concentration of Na2SO3 at 4 C instead of adding it at the time of reaction. The pretreatment of enzyme resulted in far less damage to the photosynthesis. Further experiments by diluting the enzyme liquid indicated an even clearer tendency. The enzyme disruption by SO3 will recover by simply lowering the concentration of SO3 in the liquid. The difference in enzyme activities were compared by dialyzing the solution. The dialysis clearly resulted in the recovery of activity.
Source: 1

#1805
Yatazawa, M., M. Kadota, and S. Ono. "Kokaku hanno-ho ni yoru kankyo shiryo-chu no fussoryo." (Fluorine concentration in environmental samples measured by irradiation system). Kankyo Hoken Reporto (Environ. Health Rept), 8:29030 (1972).

Fluorine in plants and soil can be measured up to 0.005 ppm by an irradiation method with a + or 8% precision rate. Fluorine is trapped with sodium hydroxide-sodium oxide and an anion exchange method is used for pretreatment. Then a F(19)/F(18) reaction is used and the radioactivity of F(18) is measured by a gamma spectrometer.
Source: 1

#1804
Yatsenko, V.M., V.S. Nikolayevskiy, and T.N. Kuznetsova. "Vliyaniye mineral nogo i nekornevogo pitaniya na nekotoryye fiziologo-biokhimicheskiye osobennosti i gazoustocychivost gazonnykh trav." (Effect of mineral and extraroot nutrition on some physiological- biochemical characteristics and gas tolerance of lawn grasses). Uch. Zap., Perm. Gos. Univ., 256:159-176 (1971).

Investigations were performed on the damageability of lawn grasses by sulfur gases such as sulfur dioxide and on the effect of mineral and extraroot nutrition on their gas tolerance. The content of oxidizable substances (water-insoluble fraction and total content) in the leaves of lawn grasses and fescue correlated by phases of growth with the damageability under the influence of fertilizers was unrelated to a change in the quantity of oxidizable substances, ascorbic acid, redox

potential, and aerobicity index. Phosphorus exerted a positive influence on the gas tolerance of lawn grasses during the second year, whereas nitrogen phosphates exerted a positive effect on the gas tolerance of fescue. Nitrogen gave a decrease in damageability in timothy with exposure to extraroot in the second year, and phosphorus did the same in fescue. The compounds exerted a less positive influence on the gas tolerance of fescue and a more positive influence on that of timothy after the first year of life. Use of monoiodoacetic acid confirmed the important role of the pentosommonophosphatic oxidation mechanism in respiration and gas tolerance of tolerant species and of the Krebs cycle in nontolerant species.
Source: 1

#1803
Yavonenki. O.F. and M.V. Shevryakov. "The effect of bivalent metal ions and air upon the intensity of reductive amination of alpha-ketoglutaric acid in the epithelium of cattle rumen walls." Ukr. Biokem. Zh., 43:526-628 (Sept/Oct 1971).

The process of reductive animation of alpha-ketoglutaric acid in the epithelial and fiberous part of cattle rumen wall was studied as affected by some bivalent metal ions and adenosine triphosphate (ATP), Manganese, cobalt, magnesium, and particularly, zinc had a stimulating effect on the process under study. The nickel ions inhibited the reaction strongly and iron ions almost caused the reaction to stop. Adenosine triphosphate evoked almost a 2.5 fold increase in the intensity of the reaction. The greatest intensity of the process was observed with the combined introduction of Zn and ATP into the incubation medium. The role of Zn in the stimulation and that of ferrous iron in reaction inhibition and on the ATP participation in this process is under investigation.
Source: 1

#1802
Yermakov, Y.G. "Bioindikatornyye metody opredeleniya zagryazneniya vozdukha." (Bioindicator methods for the determination of air pollution). Gigiena i Sanit., 8:68-70 (1974).

The use of lichens as bioindicators of air pollution, especially due to sulfur dioxide is described through examples. A standard scale of 10 grades was developed in England for the characterization of SO2-generated air pollution from the presence or absence of definite lichen species. The distribution and levels of SO2 around an industrial plant with intense SO2 emission in Canada were determined from the population and taxonomic composition of lichens on balsam poplar. The resulting map of the spread of the SO2 pollution was in good agreement with that obtained on the basis of more time-consuming chemical analyses.
Source: 1

#1801

Yokohama Center for Public Nuisance (Japan) and Yokohama Municipal Univ. (Japan) Dept. of Hygiene. "Jidosha haikigasu no eikyo ni tsuite--Namari kagobutsu ni tsuite dainiho." (Study on the effects of automotive exhaust gas: second report on lead compounds). Yokohama Public Nuisance Center Data 26, 24 p. (Sept. 1970).

Studies were conducted to determine the diffusion of lead contained in automotive exhaust and the accumulation of lead in the body. In the first study, trees growing along a side street with relatively light traffic were examined for their leaf lead content vs. that of the same species on the adjoining heavily travelled main throughfare. The results indicated that, in the absence of tall buildings and other obstructions, diffusion of lead reaches 50-70 m. As shown by results obtained in May, June, and October, the relationship between exposure time and the accumulation of lead in leaves is quantitatively proportional. In the second study, cats were exposed to exhaust gas containing about 75 ppm carbon monoxide. Blood density,hemocyte values, and hemachrome quantity increased in cats exposed to the gas for 30-100 days but decreased in those exposed for 150-202 days. This may be indicative of improved blood quality in the earlier stage of exposure and of subsequent deterioration with continued exposure. There was a marked increase of lead in blood and liver and a less pronounced increase in kidneys, lungs, spleen, and bones. The fact that the quantity of lead in lungs had no direct relationship with that in blood and other internal organs sjggests that grain size and the solubility of lead particles are important factors in body lead accumulation.
Source: 1

#38

Yonemaru, C. "On the injurious effects of sulphur dioxide upon plants." Noji Shikenjo Hokoku (Bull. Imp. Agr. Expt. Sta.), No. 47. Translated from Japanese. Mundus Systems, McGregor and Werner, Washington, D. C. 135 p. (March 1927).

The injurious effects on sulfur dioxide upon plants are relevant to the direct rays of the sun; no injuries were observed during the night or in a dark room. However, when a mixture of sulfur dioxide and aldehyde was applied to plants, the same injurious effects emerged in the dark room as under direct sunlight. These effects are therefore not caused by the sulfur dioxide alone. Aldehyde, produced by the dissolution of organic acid present in the plants, and a-Oxysulfosaure, a compound of sulfurous acid and foraldehyde produced by the union of sulfur dioxide, were also involved. That the injurious effects of sulfur dioxide were limited to instances involving direct sunlight was attributable to the fact that the formation of aldehyde is facilitated by direct sunlight. The sulfur dioxide penetrates into the plant foliage through the stoma as well as the drainage hole on the leaf margin. The stoma and drainage hole smeared by vaseline showed no

symptoms of injury. The degree of effects of sulfur dioxide greatly differed due to dry or damp air. When the air was damp, sulfur dioxide inhaling the moisture was converted not only into a minute fog shape, but also into relatively heavy sulfurous acid. Compared with ordinary gas, its movement was slow and easily stopped by plants or other blocks, thus providing ample time for penetration into the foliage. The effect of sulfur dioxide upon the yield of crops varied according to the kind of crops; the density of gas and weather conditions, with the contact by 5/1,000,000 and more capacity of sulfur dioxide, increased the injuries. Greater injuries occurred before and after the blossom period. The contact of sulfur dioxide after the blossom period influenced the new seed quality. Lists of plants tested, injuries sustained, and lengths of testing times are also included.
Source: 1

#1811

Yoneyama, T. and N. Date. "Tokyo kokagaku sumoggu no shokubutsu higai ni kansuru chosa kenkyu; 3. engei shokubutsu no taiki osen-gai ni kansuru kenkyu (2) dojo joken ga nanjaku yasai no okishidanto higai ni oyobosu eikyo ni kansuru shiken." (Investigation and studies on plant damage due to Tokyo photochemical smog. Part III: Studies on the damage of horticultural plants, (2) Experiments on the effects of soil condition to the damage of soft vegetables caused by oxidants). Tokyo-to Nogyo Shikenjo Kenkyu Nenpo, Annu. Rep. Tokyo Met. Agr. Exp. Sta., 1972:3-4 (Oct 1973).

An experiment was carried out on potted spinach and salting greens planted in soils (alluvial loam) with different pH, exchangeable cation, and with different types and rate of nitrogen and potassium (slow release fertilizer and quick release fertilizer with different rates) especially for salting greens. These vegetables were exposed to a natural oxidant. The conditions found to protect the vegetables from the attack of oxidants were: pH of neutral to slight alkaline, exchangeable cation in the normal range from 0.3 through 1.0, existance of nitrogen in nitric state and in appropriate concentration and existance of enough amounts of available potassium. The existence of nitrogen in ammoniacal states strongly aggravated the oxidant damage.
Source: 1

#1798

Yoneyama, T., N. Date, and S. Kurihara. "Nanjaku yasai-to no taiki osen higai." (Damages of soft vegetables due to air pollution). In: Tokyo Nogyo Shikenjo Sokuho, 30-32 (Feb 1974).

Toxic tolerances and thresholds of vegetables to oxidants were investigated by comparing the oxidant concentrations from 48 hr before damages occurred to the degree of damage. Nine species of vegetables were classified into three groups according to their susceptibility to oxidant damage. Vegetables highly susceptible to oxidant damage begin to show damages at less than 40 pphm, species moderately susceptible at concentrations less than 80 pphm, and those resistant to oxidants at 120 pphm. The ratio of damages between susceptible and resistant species is 10:6. Seasonal variations were recognized, and the effects of the pH of the soil are noted.
Source: 1

#1799

Yoneyama, T., S. Kurihara, N. Date, and S. Motohashi. "Nanjaku yasai no okishidanto shihyosei." (Oxidant indicatory properties of soft and weak vegetables). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, p. 703-708 (March 1974).

Soft and week vegetables were grown in 1972 and 1973 in fields of the Edogawa branch of the Tokyo Metropolitan Agricultural Experiment Station to observe the damage due to oxidant. The vegetable species were spinach, two kinds of salting green, Swiss chard, crisp head lettuce, welsh onion, kidney bean, young soy bean, and maize. The vegetables could be classified into 3 categories, the most susceptible to oxidant such as spinach and a salting green (Bekana), the moderately susceptible such as Swiss chard, crisp head lettuce, welsh onion, salting green (Komatsuna), young soy bean, and maize, and the least susceptible kidney bean. The injuries were observed at oxidant doses over 5 pphm, at less than 40 pphm-hr, less than 80 pphm-hr, and less than 120 pphm-hr respectively. The extent of damage to the vegetables exposed to the same concentration of oxidant were in the descending order spinach, Bekana, Swiss chard, and Komatsuna. A damage classification system is proposed.
Source: 1

#1800

Yoneyama, T., T. Ohashi, T. Sawada, N. Date, and S. Motohashi. "Shokubutsu no okishidanto higai ni cyobosu dojo pH no eikyo." (Effects of pH of the soil on oxidant damage of plants). In: Studies on Tokyo Smog, Tokyo Metropolitan Research Inst. for Environmental Protection (Japan), Rept. 3, 709-724 (March 1974).

In order to elucidate the relation between soil pH and plant damage, morning glory (Scarlet O'Hara), spinach, and radish were potted in soils with controlled pH in open air and in a controlled greenhouse with artificial illumination under 0.15 or 0.25 ppm ozone. Damage to morning glory included chlorosis, bleached spots, and necrosis of the leaves. Spinach and radish were dehydrated with bleached spots and necrosis of leaves. The damage to morning glory (Scarlet O'Hara) potted in alluvial soil was least when the pH of the soil was kept near 6.7, and damages to spinach and radish potted in several kinds of soil were least when the pH of the soil was kept, respectively, at 6.1-6.2 and 5.5-6.5. These values of soil pH coincided with those at which each plant is most preferably grown.
Source: 1

#721

Yoshida, Fukuko and Hajime Mori. "Fukushima shinai 4-go kokudo no kuki osen to gairoju no higai." (Air pollution and damages to trees planted along Route 4 in Fukushima City). Taiki Osen Kenkyu (J. Japan. Soc. Air Pollution), 8(3):597 (Oct. 1973).

The effects of automotive exhausts gases on trees were observed along Highway No. 4 in Fukushima. The observed trees were 319 Sophora japonica (dog pagoda trees) planted on both sides of the highway covering about 4.5 km. The period of observation was between April 1973 through the end of this fall. The young leaves began to bud about April 10, opened about April 17th, and damage began to appear from about May 10; by July and August, damages such as discoloration, shrinking, tearing, and drying up progressed considerably. Some leaves were covered by dusts as much as 10 wt% of the total weight of the leaves. The trees in the control areas in the suburbs showed almost no damage, except for some slight chlorosis. The chlorophyll measurements increased up to early July and decreased thereafter in the polluted area; the measurements were much higher in the control areas.
Source: 1

#1796

Yoshiike, A. "Dojo osen kara mita kankyo shindan-Jukinzoku, noyaku ni yoru osen no jokyo." (Environmental disgnosis by soil pollution-state of pollution by heavy metals and pesticides). Kankyo Sozo (Environ. Creation), 4(1):84-89 (January 1974).

The sources of soil pollution in Japan are believed to be 80% by industrial liquid waste and 13% by industrial combustion gases. The major pollutants are heavy metals such as copper, zinc, cadmium, lead, and arsenic, and these cause singly or in combination damages to agricultural produce. The most serious of pollutants are copper and zinc, but their single damaging effects are not as serious as single effects of Cd or As. Pollutants other than heavy metals are organochlorine pesticides, polychlorinated biphenyls, and alkyl benzene sulfonates. The history of zinc pollution is the oldest in Japan and liquid waste and stack gases from zinc mines and refineries have damaged produce seriously for many centuries. These areas are simultaneously damaged by Cd, and countermeasures for Cd pollution are urgently needed. The measures against Cd pollution will naturally control Zn pollution effects. The damages to produce by Pb are smaller than damages by Cu or Zn, and usually serious damage occurs in combination with Zn or Cu. In addition to stack gases and mine waste, soils along highways are polluted by automotive emissions. The extent of damages in Pb in automotive emission is difficult to determine at the moment. Toward control measures, the ministries of Health and Welfare and Agriculture conducted in 1970 and 1971. Thorough emergency investigations of environmental pollution in the vicinities of mines and refineries.
Source: 1

#1242

Yoshinaga, S. and S. Iki. "Kitakyushushi ni okeru dojochu no kinzoku seibun." [Soil contamination by heavy metals in atmospheric deposit in Kitakyushu City]. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):212 (1971).

The manganese, titanium, zinc, nickel, cobalt copper, chromium, cadmium, lead, and vanadium contents in soil collected at ten polluted locations in Kitakushu City were measured and compared with those in the unpolluted area, Fukuoka and Kyoto City. The metallic composition of soil was very similar to that of suspended particulates and deposited particulates. The metallic content in soil of Kitakushu City were generally higher than the Clark's number, particularly Zn, Cu, Cd, Pb, and V content.
Source: 1

#256

Yoshinaga, S., S. Iki, T. Nishimura, T. Nagaishi, and M. Matsumoto. "Kita-Kyushu ni okeru dojo to shorubutsu no jukinzoku siebun." (The contents of heavy metals in soil and plants). Proc. Symp. Japan Soc. Air Pollut., 13th, paper 48, p. 93 (1972).

Pollution of soil and plants caused by air pollutants such as soot, dusts, industrial emissions, and automotive exhaust gases was examined. The heavy metal content in the soil and plants of heavily industrial Kita-Kyushu city and those of non-polluted areas of Fukuoka were compared. Soil and plants were liquefied by potassium carbonate and sodium carbonate, and the manganese, zinc, nickel, cobalt, copper, cadmium, lead, and chromium content was measured by atomic absorption spectrophotometry, and titanium and vanadium content by colorimetry. Generally, plants contained much Mn, Ti, and Zn, and soil contained much Mn, Ti, Cr, and Pb. The metal composition in the soil was very similar to the metal composition found in settling particles. There was a clear correlation between the content of the settling particles and the metal composition of the soil in the same area. However, the degree of absorption of metals by the plants grown in the soil showed no correlation with the settling particle content. The degree of absorption of metals obviously varied among the species.
Source: 1

#1795

Young, Michael John. "The effects of gaseous fluoride on delicious and golden delicious apples." Washington State Univ., Pullman, Dept. of Horticulture, Thesis (Ph.D.), Ann Arbor, Univ. Microfilms, Inc., Order No. 73, p.29,311 (1973).

Atmospheric fluorides were monitored in apple and other fruit orchards around two adjacent sources of fluoride emissions in the Wenatchee, Washington fruit growing area, and Delicious and Golden Delicious trees were fumigated with low (4.6-4.7 micrograms F/cu m) and high (7.8-9.0 micrograms F/cu m) fluoride levels once, twice, or three times a week. The effects of fluorides on fruit trees were then determined. Exposure of limed filter papers was a more sensitive method of detecting ambient fluroides than analysis of apple tree foliage. However, both methods were adequate in the determination of the fluoride distribution pattern in the study area. Considerably higher levels of fluoride were detected at sampling sites downwind of the emission sources.

Fluoride-induced tip necrosis on apple leaves was observed in one orchard where a mean seasonal limed filter paper value of 82.4 micrograms F/d sq m/mo and 22.5 F in the washed foliage were recorded. Tip necrosis increased as the F level and frequency of exposure increased. Leaf respiration was inhibited at the lower but not the higher F fumigation level. Furit respiration was stimulated to equal levels by the two F concentrations used. A trend toward increased inhibition of fruit ethylene production of lower exposure factors was observed. The loss of green color in the skin of treated fruits was retarded relative to an increase in the F level and the exposure frequency. With the exception of leaf respiration, where an inverse relationship was found, the degree of response with respect to leaf injury, fruit respiration and color were directly affected by the exposure factor used. Within the scope of this study, fruit shape, firmness and soluble solids were not affected by the treatments.
Source: 1

#1211

Zahn, R. "Über den EinfluB verschiedener Umweltfaktoren auf die Pflanzenempfindlichkeit gegenüber Schwefeldioxyd." (The influence of various environmental factors on the sensitivity of plants to sulfur dioxide). Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz, LXX: 81-95 (1963).

Fumigation tests with defined SO_2 concentrations carried out under various meteorological conditions indicate the great influence of the weather (temperature, humidity, light) on the sensitivity of plants. The special importance of the water content of the soil is emphasized. It is quite possible to render the stimulation threshold period ten times as long as the period of maximum plant sensitivity. The necrophobic action of a climatic factor can to a certain degree be compensated for by necrophilic factors. Fumigation at different times of the day produced sensitivity curves that showed a maximum approx. 4 hours after sunrise on both sunny and cloudy days. The nocturnal SO_2 action which, compared to a daily average, is approximately 4 times less toxic, becomes significant if the action continues day and night without interruption. A considerable influence of the SO_2 sensitivity of the broad leaved plants is exercised by their supply of nutrients. Increasing doses of mineral nitrogen caused increasing resistance which, in contrast to increased resistance as the result of diminished SO_2 absorption, is probably caused by physiological changes in the cells. Phosphorus and potassium, even if administered in large quantities, are as a rule without effect. Possible exceptions are plants with special phosphorus and/or potassium requirements. A positive resistance effect of manuring could not be found with cereals.
Source: 6

#883

Zahn, R. "The limits of sulfur dioxide effects upon plants." Staub, Reinhaltung Luft (German), 29(9):36-38 (Sept. 1969).

New opinions regarding the resistance of vegetation to sulfur dioxide cite the damage limit for plants is not to be 0.2 ppm, as previously assumed, but 0.02 ppm. Methods used to obtain the 0.2 ppm value are discussed and the value is compared to mean values of SO2 concentration over an extended period of 0.02 ppm. The constant concentration of 0.2 ppm used in an extended fumigation test and the mean value of 0.02 ppm (obtained in an industrial region comprising many different individual values) are not comparable in their effects on plants. Neither mean values over extended periods, nor maximum allowable concentrations, are suitable criteria for characterizing and assessing SO2 emissions. The former are not precise and liable to constitute a hazard to vegetation, the latter are too rigid. Immission limits must have a certain flexibility, which is probably best achieved by replacing fixed values with a cumulative frequency curve.
Source: 1

#884

Zahn, R. "The effect of plants of a combination of subacute and toxic sulfur dioxide doses." Staub (English translation from German of: Staub, Reinhaltung Luft), 30(4):20-23 (April 1970).

Alfalfa plants were found able to withstand interim loads (i.e., loads between really toxic doses) of 0.1 to 0.2 ppm sulfur dioxide. Pretreatment of the plants with 0.2 ppm SO2 prior to toxic doses slightly reinforced the effect of the latter. Barley plants pretreated with 0.3 and 0.6 ppm showed no damage at all after exposure to 1.2 ppm SO2. Wheat pretreated with 0.4 ppm SO2 showed reduced damage from exposure to 0.8 ppm SO2. Larch also showed a positive pretreatment reaction. The positive effects of pretreatment were observed only for daytime fumigation. For monocotyledons and some conifers, subacute fumigations appear to be an immunization process through which certain oxidases are reformed or reactivated. The oxidation of these oxidases accelerates the decontamination of the SO2 introduced into the cell by the toxic doses.
Source: 1

#1241

Zdrazil, J. and F. Picha. "The occurrence of the carcinogenic compounds 3,4-Benzpyrene and arsenic in the soil." Neoplasma, 13(1):49-55 (1966).

Soil sample analyses for the carcinogens arsenic and 3,4-benzpyrene were made in an urban environment surrounding a coal-burning steam electric plant. Coal was also used for urban heating in the area. Soil samples from gardens in the housing district contained concentrations of 3,4-benzpyrene ranging from 0.026-0.939 mg/kg. Arsenic levels (near the power plant) were as high as 37.0 mg/kg, though values in the dwelling area did not exceed 10 mg/kg. Concentrations of 3,4-benzpyrene in the immediate vicinity of the power plant ranged between 0.22-0.112 mg/kg, while those near a railway track were higher, ranging from 0.312-2.040 mg/kg. Analy-

ses of flue dust collected from power plant stacks showed only minute amounts of 3,4-benzpyrene (0.003 mg/kg) and concentrations of arsenic ranging from 43.0-110.4 mg/kg, while concentrations of the two pollutants in the soot of local heating equipment chimneys ranged from 26.0-78.0 mg/kg and up to 57 mg/kg, respectively. The soot from steam locomotive shed chimneys showed abnormally high 3,4-benzpyrene concentrations (427.5-675.0 mg/kg). Soil samples from a nonindustrial area where railroad and heating exhaust emissions were absent showed 3,4-benzpyrene concentrations ranging from 0.002-0.127 mg/kg.
Source: 1

#257
Zieger, Erich. "Rauchschaeden im Walde." (Smoke-induced damage to forests). Wiss. Z. Tech. Hochsch. Dresden, 3(2):271-280 (1953-1954).

Problems of smoke-induced damages and appropriate control measures are reviewed. Fly ash and waste gases are the pollutants involved in forest damages. Fly ash depositing chiefly in zones of 100-600 m around high stacks turns the soil gradually sandy. Sulfur dioxide is the most dangerous of all waste gases, followed by sulfuric acid, hydrofluoric acid, nitric acid, fluorine compounds, ammonia, hydrogen sulfide, and tar vapors. Both the character and the measure of the damages are determined by such factors as distance from the emission source, dilution, and season. Regarding damages due to etching, different species show different degrees of resistance, conifers being highly sensitive. Damages due to disturbed assimilation are most important in humid weather and in old needles. The sensitivity increases with increased assimilation activity. The incrustation damages caused by dust build-up on leaves and needles are of a local character. The pollutants also affect the soil, turning it acid, and changing its physical and chemical properties. The control measures should be applied at the emission source proper. The fine fractions of the fly ash, amounting to 50-75%, are hard to retain, and high stacks cannot be regarded as an adequate solution. Various methods of dust separation are discussed. There are no adequate methods for sulfur dioxide control available. The breeding of smoke-resistant stands, the plantation of shelter woods, and liming are some of the steps to be taken by forestry.
Source: 1

#746
Ziegler, L. "The effect of air-polluting gases on plant metabolism." Environ. Qual. Saf., 2:182-208 (1973).

Among the air-polluting gases, SO2, ozone, peroxyacetylnitrate (PAN) and fluorine are those whose action is studied most. This review tries to show the connection between the well-known macroscopic symptoms, on the one hand, and the primary points of attack at the enzymatic level, the changes in the plant's metabolism, and the microscopic and electronmicroscopic results, on the other. PAN and ozone, which originate through the action of sunlight on auto-exhausts, cause the strong oxidizing character of this type of smog. Their primary point of attack seems to be their oxidizing effect on protein SH-groups. PAN in special oxidizes the SH-groups of a photoreducible disulfide containing chloroplast protein, thus blocking

photosynthesis. SO2, which originates from combustion of coal and petroleum as well as from roasting of sulfur-containing ores, causes the reductive character of this type of smog. SO2 has a special position among the air-polluting gases because it can be incorporated without damaging effect into the normal sulfur metabolism up to a certain level. After exceeding this limit, it causes a rapid depression of photosynthesis. Its primary point of attack thereby, however, is scarcely known. F- is bound as a salt in the cell wall or in the cell vacuole and is thereby prevented from its damaging effect on metabolic processes up to a certain level. Upon exceeding this, it acts mainly on the enzymes of carbohydrate metabolism. The action of air-polluting gases on the permeability of cell membranes will deserve special interest in the future. In a few examples it is shown in which way the collapse of cell compartmentation causes the loss of regulatory mechanisms of the cell. The influence of internal (genetic conditions, physiological age, etc.) and external (light temperature, humidity, etc.) factors on the general metabolism, and, in this way, on the sensitivity of the plant to air-polluting gases, is shown.
Source: 2

#61
Zimdahl, R. L., "Lead in soils and plants." In: Impact on Man of Environmental Contamination Caused by Lead. Interim Report. July 1, 1971 to June 30, 1972. Colorado State Univ., Fort Collins, National Science Foundation Grant IRRPOS GI-4, RANN GI-34813X, p. 98-123 (1972).

The contamination of roadside soil and plants by automotive lead was studied along an interstate highway in Colorado and in the laboratory. A major portion of the lead emitted by automobiles traveling on the interstate was deposited within 50 ft of the highway. The lead moved downward into the soil at a very slow rate. Values up to 1000 ppm occurred adjacent to the highway. The background lead level for soils in the same area was approximately 22 ppm. Soil sorption studies showed that equilibrium occurs within 48 hr. Studies of seven different soils with varying characteristics showed that the Langmuir sorption equation best describes the Process; that is, each soil showed a maximum value for the sorption of lead. The capacity of the soil to sorb or immobilize lead was correlated with the cation exchange capacity of the soil. This effect was attenuated by pH which decreases the capacity of the soil to sorb lead and in theory should make the lead more available to plants. Studies with plants grown in hydroponic culture and then exposed to lead nitrate solutions showed that several different plants have a great capacity to take up lead from solution. Soil studies showed a relationship between soil lead levels and the amount of lead taken up by the plant. Foliar uptake of lead was studied with a special apparatus. Studies involving detached cuticles showed very little transport of lead across the foliar cuticular barrier.
Source: 1

#376
Zimdahl, R.L. and J.H. Arvik. "Leads in soils and plants: A literature review." CRC Critical Rev. Environ. Control, 3(2):213-224 (Feb. 1973).

The distribution of lead in the environment is altered by the activities of man, principally through its use as a fuel additive. Lead appears in automobile exhaust as halides, hydroxides, and oxides, with lesser amounts of carbonates and sulfates. Lead concentrations decrease rapidly with depth in the soil and distance downwind from a source, and show a positive correlation with traffic volume. Lead in soil is moved slowly by leaching due to sorption and formation of insoluble compounds. Sorption of lead by soils is positively correlated with cation exchange capacity. Lead can be taken up by plant roots if in an available form, but the soil sorption phenomena and precipitation prevent uptake of large amounts unless soil lead levels are extremely high. Lead can be absorbed by plant foliage but much of it is apparently in the form of a surface deposit. Lead content of plants grown in natural soils is generally less than 10 ppm dry weight. When taken up by a plant, lead may be found principally in the roots, with little translocation to the shoot. Lead uptake is enhanced by low soil pH and can be reduced by liming the soil.
Source: 1

#722
Zimmerman, Percy W. "Effects on plants of impurities associated with air pollution." Proc. U.S. Tech. Conf., Washington, D.C. 127-139 (May 3-5, 1950).

Studies of the effects of low concentrations (0.1-0.2 ppm) of sulfur dioxide on alfalfa under different conditions of temperature, water, and nutrient supply; sulfur content of nutrients and age of plants showed that resistance to SO2 at 40 F or below is greater than at higher temperatures. Drying the soil to a point that causes wilting also increases resistance to the gas. Plants tend to recover between treatments if enough time elapses. Plant susceptibility during treatment increases with light up to full sunlight. Yound plants are more resistant than old plants, while middle-aged leaves are more most susceptible. The susceptibility of various species and the characteristic symptomatology are described. The results of experimental fumigations of plants with 0.05 to several ppm hydrofluoric acid gas in air are detailed, and similar studies of the effects of chlorine, hydrogen sulfide, ammonia, mercury vapor, ethylene and carbon monoxide, and the vapors of 2,4 dichlorophenoxyacetic acid and other hormone-like herbicides are reported.
Source: 1

#885
Zimmerman, P.W. and William Crocker. "Plant injury caused by vapors of mercury and compounds of mercury." Contrib. Boyce Thompson Inst., 6(1):167-187 (Jan-March 1934).

Experiments were performed to determine the effect of vapors of mercury and its compounds on growing plants when exposed under various conditions. Treating one bed of soil in a rose house with bichloride of mercury injured flowers of Briarcliff variety over the entire range, showing that the plants were attacked by some inpurity in the air. Flower buds of roses in all stages of development were affected by the vapors emanating from soil treated with bichloride. Peduncles of very young buds turned yellowish and then black; half mature buds turned brown, and the corollas abscissed from the receptacle without opening; the older buds continued to unfold but the petals

lacked the pink color characteristic of Briarcliff variety and brown patches finally developed; stamens also were injured, turning nearly black in half mature buds. Leaves of rose plants confined in glass cases with treated soil were injured as well as flower buds. Plants of 65 different genera were found susceptible to injury from vapors emanating from soil or tankage moistened with bichloride solution. Ten types were found to be comparatively resistant. The injury to plants from vapors from metallic mercury was similar to that caused by vapors emanating from soil treated with bichloride. Thirteen other compounds of mercury affected plants as reported for bichloride; of these six were organic, and seven inorganic. The extent of the injury and the rate at which metallic mercury injured plants varied with the concentration of the vapor in the air and this in turn varied with the temperature. Vapors from soil treated with mercury compounds injured plants more quickly at high than low temperature. In general, the amount of injury at a given temperature could be correlated with mercury vapor pressure at the same temperature. Metallic mercury vapor was detected in the air surrounding soil treated with the mercury compounds, indicating reduction to the metallic state. Mercury was recovered from leaves of plants confined in glass cases where a small amount of soil had been moistened with a solution of bichloride.
Source: 1

#1793

Zimmerman, P.W., William Crocker, and A.E. Hitchcock. "The effect of carbon monoxide on plants." Contrib. Boyce Thompson Inst., 5:195-211 (1933).

The effects of carbon monoxide on root formation and growth were investigated in 108 species of plants. Most of the plants were exposed to 1% CO under bell jars or in Wardian cases. Forty-five species showed epinastic growth of leaves. Several species showed hyponasty which caused upward curling of leaves. Stem elongation of most species was retarded, varying with the concentration of the gas. New leaves produced while the plants were in carbon monoxide were normal in shape, but were abnormally small. Injury was evidenced by abnormal yellowing of the leaves, beginning with the oldest. Abscission of leaves was usually associated with yellowing, though in a few cases, abscission of young leaves occurred without yellowing. Carbon monoxide gas caused hypertrophied tissues on stems and roots of most species. During recovery an abnormally large number of side shoots arose from latent buds of many species. Motion pictures of Mimosa pudica showed that carbon monoxide gas caused the leaves to lose their correlation and change their normal equilibrium position to gravity. They lost their sensitiveness to contact or heat stimuli but the leaves moved about more rapidly than those of controls. Plants exposed for only 24 hr were not badly injured and recovered to approximately normal conditions within a day. Since carbon monoxide causes growth rigor and loss of sensitiveness to external stimuli, it is considered as an anesthetic. This conclusion is supported by the fact that animals which do not have hemoglobin are readily anesthetized by an 80% carbon monoxide air mixture of the gas.
Source: 1

#260
Zimmerman, P. and R. Rasmussen. "Identification of soil denitrification peak as N20)." Environ. Sci & Tech., 9(12):1077-1079 (1975).

Researchers working with soil samples in closed systems should be aware of the possible production of high levels of N20 by some soils. The measurement of this compound is possible during FID gas chromatographic analysis, although high CO2 levels may interfere with quantification.
Source: 5

#157
Zinke, P. J. "Forest interception studies in the United States." In: Int. Sym. on Forest Hydrology. W. E. Sopper & H. W. Cull, ed., Pergamon Press, Oxford, England, pp. 137-161 (1967).

This paper reviews the American literature with regard to studies of forest interception. The review is placed in the context of the water balance for a watershed so as to maintain perspective on the role of interception in the hydrologic cycle. The literature is reported with regard to definitions, relationships between interception quantities and relevant variables, and methods used in measuring these. The data that have been reported in the literature for interception storage, for stem flow, and for interception losses are presented grouped by major forms of vegetation and by vegetation species. Ramification of these processes into air drops of fire retardants, etc. are discussed. The current status of research into interception processes indicates that a major current problem is whether this process represents a true evaporative loss in the water balance of the forest in addition to that of potential evapotranspiration loss.
Source: 7

#886
Zuber, R., E. Bovay, M. Roulet, and W. Tschannen. "Die Verunreinigung der Atmosphaere und ihr Einfluss auf die Pflanze." (Atmospheric pollution and its effect on the plant). Schweizerische Gaertnerzeitung (Zurich), 73(19): 233-236 (May 1970).

Sulfur dioxide penetrates into the interior of leaves more readily at higher temperatures, under bright light, and at high humidity than in cold and dry weather and in darkness. The plant has a defensive mechanism in that it oxidizes the sulfite ion to a sulfate ion 30 times less toxic. Fluorine emissions from aluminum works, glass works, brick factories, ceramic factories, phosphate fertilizer plants, and from the manufacture of hydrofluoric acid can be controlled by the Harding-Desbaumes device which absorbs not only gaseous fluorine compounds but partly also solid fluorine compounds in dust and in aerosol. Fluorine is absorbed by plants principally through leaves, and only to a small degree through root from the soil. Its distribution in the plant is uneven with content high in roots, leaves, and stems. Fluorine compounds cause plasmolysis of the cell content and thus the death

of cells manifested by necrotic plant tissue. Chlorine and hydrochloric acid, which cause burns in plants, now contaminates the atmosphere only rarely; ammonia has a similar effect. Dust from cement factories and metallic oxide dust cause plant necrosis. Of automobile exhaust pollutants, saturated hydrocarbons, nitrogen oxides and organic acids are less phytotoxic, while ozone, nitro-derivatives, and peroxyacetyl nitrate are more so. Lead emissions do not seem to cause severe damage to plants even at high levels but are dangerous indirectly to animals and humans.
Source: 1

#519

Zuber, P.R., B. Bovay, W. Tschannen, and J.P. Quinche. "Le plomb comme facteur de pollution atmospherique et son accumulation sur les plantes croissant en bordure des arteres a forte densite de circulation." (Lead as a factor of atmospheric pollution and its accumulation on the vegetation along the roads with high traffic density). Schweiz Landwirt Forsch, 9(1):83-96 (1970).

The investigations and experiments made in Switzerland in 1969 confirm those of 1967-68 as to the fact that lead deposits from the exhaust gases of motor-cars (antiknocking additives) are especially high in the immediate surroundings of roads with high traffic density. The amounts of lead may exceed 100 ppm Pb in the dry matter of the plants.

If these lead deposits decrease rapidly with the increasing distance from the road, the pollution is still perceptible even as far as 100 meters from the road, as the dispersion of the lead particules is dependent from the local orographic conditions and from the direction of the prevailing winds, as well as from the traffic volume in summer.

The meteorological conditions seem to exert a marked influence on the level of the pollution: in raining times, the lead particules in the atmosphere as well as on the plants are washed down, so that the amounts of lead deposits on the leaves are reduced.

Washing of the plants in current water enables to remove between 30 and 65% of the lead deposits, confirming the fact that these deposits are principally coming from the atmosphere and that their nature is superficial. Nevertheless, it has been observed that soils with high amounts of lead or soils artificially enriched with lead composits, even in a rather unsoluble form like oxide and carbonated, also determine increases of the lead amounts in the plants. The quantity of lead on the plants along the roads with high traffic depends upon the nature of the organs of the plants: large and displayed leaves (e.g. spinach), as well as definite dissected leaves (e.g. celery, fennel, carrots) or organs with a rough or a hairy epidermis, such as the glumes and the straws of the cereals or the downy fruit species (e.g. apricots) retain more lead than smooth, narrow and erected organs.

In Switzerland, it has been observed that root-vegetables growing along the highways did not still show a perceptible lead contamination.

On an other way, plants cultivated on soils with a very high lead content (up to 500 ppm) do not seem to present any sign of intoxication nor any failure of yield.

It is however important to be exactly aware of the reactions determined on the animal and human physiology by the ingestion of vegetable material contaminated with lead deposits from the exhaust gases of motor-cars. Trials with fodder-ing milk cows using pellets of grass harvested along a highway proved that a high proportion of the ingested lead was eliminated whith the solid and liquid dejections. The experiments on this subject are still going on.
Source: 2

#258

Zuber, R., P. Moeri and E. Bovay. "L assorbimento del piombo da parte della pianta tramite la radice. Con studio particolare sull attivita enzimatica." (Lead uptake by the roots of plant. Study of the action of lead on enzyme activity). Schweiz. Landwirt. Farschung, 12(4):291-306 (1973).

Experiments were performed to determine the relationship between lead uptake by the roots of Italian Raygrass and crop yield and to assess the effectiveness of peroxidase activity assay as an indicator for invisible plant damage. Three acid soils with different pHs and different physical and chemical properties were mixed with equal amounts of fertilizer, different does of lead carbonate, and increasing amounts of calcium carbonate in order to obtain an increasing scale of soil pH. Crop yield increased as the amount of lead in plant tissue decreased for increasing alkalinity of the soils used. Minimum absorption at increased pH values was most pronounced with the highest concentration of added lead. Determination of peroxidase activity by spectrophotometric absorption measurement of para-phenylenediamine oxidized by peroxide in the presence of peroxidase proved to be an indicator for plant damage. A decrease in lead resorption with increasing soil pH in connection with increasing crop yield corresponded to a decrease in peroxidase activity.
Source: 1